Response to United States Environmental Protection Agency Request dated March 8, 2018 on the Back Forty Project Wetland Permit Application

Submittal No. 2NN-5PE0-MT3W USEPA Reference No. WW-16J

Project I.D.: 17A021.18

Aquila Resources Inc. Stephenson, Michigan

April 2018







April 5, 2018

Mr. Christopher Korleski Director, Water Division United States Environmental Protection Agency Region 5 77 West Jackson Boulevard Chicago, IL 60604-3590

Dear Mr. Korleski:

Re: Response to USEPA March 8, 2018 Comment Letter

Enclosed is Aquila Resources Inc.'s (Aquila) response to your March 8, 2018 letter to Ms. Colleen O'Keefe of the Michigan Department of Environmental Quality (MDEQ) commenting upon Aquila's Wetland Permit Application for the Back Forty Project.

Aquila believes the enclosed information thoroughly addresses your questions about the Back Forty Project relative to the Wetland Permit Application and that this information will allow for expeditious resolution of the federal review process of the MDEQ permit application. Please be advised we are also working directly with the MDEQ to resolve concerns they have expressed during the course of their ongoing review.

We look forward to continue working with you and your staff in resolving any remaining questions you may have. In the meantime, please do not hesitate to call me or the Aquila team with any questions.

Barky Hildred

Sincerely

President and CEO

cc: Kristi Wilson, MDEQ

Kim Fish, MDEQ

Teresa Seidel, MDEQ Colleen O'Keefe, MDEQ

Response to United States Environmental Protection Agency Request dated March 8, 2018 on the Back Forty Project Wetland Permit Application

Project ID: 17A021

Prepared for **Aquila Resources Inc.**

Stephenson, Michigan

Prepared by

Foth Infrastructure & Environment, LLC

April 2018

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Introduction

This document was prepared in response to a March 8, 2018 letter of objection addressed to the Michigan Department of Environmental Quality (MDEQ) from the United States Environmental Protection Agency (USEPA)¹. The USEPA objection letter consolidates comments from the United States Army Corps of Engineers (USACE) and the United States Fish and Wildlife Service (USFWS) on the Aguila Resources Inc., (Aguila) Wetland Permit Application (Application) Public Notice No. 2NN-5PE0-MT3W. The USEPA March 8, 2018 letter includes comments that relate to prior comments from the MDEQ to Aquila. With respect to those MDEQ comment letters (dated January 19, 2018 and March 2, 2018), Aquila has recently provided response documents (Foth, 2018a, and Foth 2018b) which are available to USEPA through the MDEQ. In correspondence dated March 19, 2018 from MDEQ to Aguila, MDEQ provided a list of information required to address the USEPA comments. That letter requested extensive information (including information addressing items that were not raised by USEPA) that Aquila has already largely addressed in its responses to the MDEQ letters dated January 19, 2018 and March 2, 2018. In addition to this document, responding directly to USEPA's comments, and Aquila's prior responses to MDEQ comments (Foth, 2018a and Foth, 2018b), Aguila will provide to MDEO a formal response to MDEO's March 19, 2018 letter.

To assist in navigating this document and to provide clear responses, Aquila has organized its responses around the USEPA comment letter. Specifically, the first seven bulleted comments from the March 8, 2018 USEPA letter were assigned consecutive numbers 1 through 7, and were grouped with their corresponding bulleted response requirements that followed in the letter. The seven bulleted comments from the letter and their corresponding listed response requirements are provided in this document in italics prior to the responses. The USEPA letter also contained an enclosure. Several comments appear in the enclosure that were not included in the USEPA letter and therefore not part of USEPA's formal comments. However, Aquila addresses these comments under Miscellaneous Comments at the end of this document.

Comment #1: Project Description

The applicant has not provided a complete description of the project, including a final site plan identifying the final location of key project features, including storm water and waste management features. The proposed site layout is not consistent with the approved state Permit to Mine. Nor are all impacts of the project identified in the application, including impacts caused by any planned underground mining, a power plant, and mining water management systems. Without this information, the reviewing agencies cannot adequately assess the extent of the proposed mine's impact on aquatic resources required by the CWA, and or determine whether the applicant has minimized and avoided aquatic resource impacts, as required.

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¹ The USEPA's March 8 letter constitutes the agency's formal "objection" to issuance of the wetlands permit pending resolution of USEPA's comments. Aquila notes that USEPA's review of Aquila's permit application and issue of objections did not comply with the notice procedures for objections set forth in Section 404 (j) of the federal Clean Water Act. However, Aquila believes USEPA's comments are readily addressed.

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Response #1:

The Application does contain a final site plan that notes the extent of the mine pit, internal haul roads, the limits of lined mine waste storage areas, the location of lined contact water basins, processing plant location and layout, ore stockpiles and blending area, overburden stockpile areas, and non-contact water basins that will receive storm water runoff from the overburden stockpile area. These features are displayed on Figure 4-3 of the Application.

USEPA is correct that the final site plan in the Application is different than the layout of the Project contained in the Part 632 Mining Permit (MP 01 2016). As noted in the Aquila cover letter of the Application, the site plan (final site plan) reflects additional engineering analysis and design of the preferred alternative integrated with an assessment of potential regulated resource impacts. The final site plan reflected in the Application thus reflects a site plan that takes into account further engineering analysis and evaluation of alternatives as required and documented in the Application. This issue was addressed further in responses to MDEQ comments dated March 2, 2018 (Foth, 2018b). As noted in response to Comment #2.8 (Foth, 2018b), Aquila will be required to obtain conforming amendments to the Mining Permit upon issuance of the Wetlands Permit, a process that is allowed under MDEQ Rules.

The Project location and properties within the Project Boundary are addressed in Response #1.2 (Foth, 2018b). With respect to impacts associated with inferred underground mining, a power plant, mine water management, and plans for road improvements, please note the following:

- Underground mining is not authorized by the Mining Permit (MP 01 2016), and Aquila has no plan to mine underground at this time. There is deeper mineralization associated with the deposit. Aquila is required by Canadian law to disclose this information to the public. Should Aquila ever seek to develop this deeper mineralization via future underground mining, they would need to complete a new mine permitting effort at that time.
- There is no power plant proposed for the Project. Electrical service is proposed by constructing a new 138 kilovolt transmission line take-off through an upland area from an existing transmission line east of the site. A substation will be installed on the Project site in the location described in Response #2.7 (Foth, 2018b).
- The mine water management systems are regulated under the Mining Permit (MP 01 2016) and the National Pollutant Discharge Elimination System (NPDES) Permit (MI0059945). The Mining Permit regulates the design of liner systems used for facilities such as the mine waste storage areas so as to protect groundwater quality. The Mining Permit also regulates soil erosion and sediment control during the construction process. The NPDES Permit regulates the management of mine waters. Under the NPDES Permit, all water that comes in contact with the mine pit, mine waste storage areas, and operations area, will be routed to the lined contact water basins. Water in the contact water basins will either be re-used in the mill or treated at the wastewater treatment plant prior to discharge to the Menominee River. The NPDES Permit also regulates storm water runoff from the overburden stockpile area. The NPDES Permit also contains requirements for preparation of a Storm Water Pollution Prevention Plan (SWPPP) as part of project implementation. It is recognized that like the Mining Permit, the NPDES

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Permit may also require an amendment prior to site construction. Aquila plans on engaging MDEQ permitting staff to discuss these permit amendments once Aquila knows that the Wetland Permit is forthcoming. With respect to the NPDES Permit, please note that the NPDES Permit was reviewed by USEPA prior to issuance and reflects USEPA input with respect to monitoring requirements such as mussel toxicity testing. The monitoring plan contained in the NPDES Permit includes numerous water monitoring stations in the Menominee River and other rivers and water bodies surrounding the Project. Further information is provided in Response #3.

- An explanation of the Project impact on River Road is included in the response to MDEQ comments of March 2, 2018, Response #2.3 (Foth, 2018b). There are no other road realignments or widening of existing roads that are needed for the Project.
- The Application contains a document that evaluates project alternatives to minimize and avoid impacts to the extent practicable, and Aquila's March 23, 2018 response to MDEQ comments dated March 2, 2018 (Foth, 2018b) was offered to further amplify and clarify the lack of practicable alternatives to further avoidance of wetland impacts.

Comment #2: Menominee River Bank Stability/Erosion

The mine pit is located next to a bluff above the Menominee River and the application currently lacks information that would allow the reviewing agencies to ensure mine pit integrity with respect to the boundary of the river and associated flood plain, including an analysis of slope stability and erosion at the river bank. The application lacks information regarding how the project will include means to stabilize these features, including to address U.S. Fish and Wildlife (and EPA) concerns regarding potential risks to the project and the river from heavy rains. Lack of this information means the reviewing agencies cannot understand the project's potential impact to aquatic resources.

Provide additional documentation of Menominee River bank stability/erosion potential to demonstrate mine integrity.

Response #2:

The following memoranda were prepared by Golder Associates Ltd. to document the stability and erosion potential for the Menominee River bank:

- Attachment 2.1: Menominee River Bank Geotechnical Stability Analysis (Golder Associates, 2018a).
- Attachment 2.2: *Menominee River Historical Channel Migration* (Golder Associates, 2018b).

A stability analysis of the Menominee River bank is provided in Attachment 2.1. The analysis was performed at three critical cross-section locations along the cut-off wall, under static and pseudo-static conditions, assuming dry, 100-year flood, and 1,000-year flood conditions. The calculated minimum Factor of Safety (FS) for a failure scenario that breaches the cut-off wall is above 4 under static conditions, and above 3 under pseudo-static conditions. These high FSs

indicate that the risk of a failure event occurring during the operational period and beyond is negligible.

To further analyze the stability of the embankment and river channel, a geomorphology study that documents the channel migration that has occurred in the Menominee River is provided in Attachment 2.2. As shown in Attachment 2.2, the Menominee River flowing past the proposed mine pit is stable and the likelihood of the river eroding from the existing floodplain to the cut-off wall over the operational life of the mine and beyond is negligible.

Operationally, Aquila will monitor the embankment per the conditions included in the Mining Permit (MP 01 2016). Those conditions require the following:

- Prior to construction, Aquila will submit to MDEQ a final design plan on the construction of the cut-off wall (Special Permit Condition K20).
- The design plan will include specifications on the monitoring of the performance of the cut-off wall and monitoring the stability of the river bank (Special Permit Condition K21 and K22).
- The design plan will also include a response plan for actions that will be taken if monitoring data indicate the potential for movement of the bank (Special Permit Condition K24).

Based on the analysis described in Attachments 2.1 and 2.2 and the Mining Permit conditions related to the cut-off wall and river bank, there is a high level of confidence (and regulatory oversight) to conclude that the integrity of the cut-off wall will not be compromised by extreme flow events in the Menominee River.

Comment #3: Protecting Water Quality of the Menominee River

The application states that the project will not adversely affect water quality of the Menominee River but does not explain how the project will be managed to ensure discharges will meet water quality standards, including sufficient monitoring locations, minimization measures, and adaptive management procedures to prevent leaching of toxic compounds from mine storage facilities and from the mine pit into the River, a concern EPA shares with the Corps.

Provide additional details regarding monitoring, impact criteria, and specific adaptive management mechanisms sufficient to demonstrate avoidance and minimization of impacts to aquatic resources and prevention of contamination and unanticipated discharges.

Provide demonstration and supporting documentation that the mine site plan is protective of water quality throughout the life of mine and post-closure.

Response #3:

Summary Response

The regulation of potential impacts to water quality due to the release of regulated pollutants from the Project site has been thoroughly evaluated and assessed as part of other permits that have been issued for the Project. The Mining Permit (MP 01 2016) and related administrative

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rules regulate those aspects of the Project that could affect groundwater quality. This includes engineering specifications for liner design for the mine waste storage areas, reclamation standards to avoid perpetual care, and monitoring requirements for groundwater and surrounding surface water. Additionally, ongoing waste characterization and pit hydrogeologic studies to aid ultimate reclamation of the site and the long-term protection for water resources such as the Menominee River are permit requirements. NPDES Permit MI0059945, which was reviewed by USEPA Region 5, contains permit conditions relating to regulated discharges, and monitoring and reporting requirements for surface water discharges to the Menominee River associated with the Project. Finally, the Mining Permit also includes an evaluation of long-term potential impacts on water quality in the Menominee River due to potential releases from the backfilled pit. All of the issues raised in this comment have been reviewed as part of other permits issued for the Project. The remainder of this response provides additional detail on each of these topics related to water quality.

Contact Water Management During Operations

Contact water (water that contacts reactive materials including ore, waste rock, and tailings, etc.) will be collected and routed to the contact water basins. Contact water includes leachate from lined storage piles, precipitation that falls on the plant area, and inflow from the pit as the mine is developed. This collected water will be re-used in the ore processing operations and other facility uses. Excess water will be treated by the wastewater treatment plant (WWTP) prior to discharge to the Menominee River at the proposed outfall noted in the Application.

The treated water discharge to the Menominee River is permitted under NPDES Permit MI0059945. The current permit expires in 2020 and permits must be renewed every five years. All discharges from the Project to surface water that could contain a pollutant as defined in the Clean Water Act are regulated under this permit during operations. The effluent limits consistent with Michigan water quality standards are provided in the permit as well as monitoring requirements. Besides a suite of chemical parameters, whole effluent toxicity testing is required on Ceriodaphnia dubia and Pimephales promelas and mussel species Amblema plicata or alternative. Testing is to be consistent with USEPA guidelines. The requirement for mussel toxicity testing is based on USEPA's review of the permit prior to issuance. The extensive monitoring plan contained in the NPDES Permit encompasses a broad range of surface water monitoring points in the Menominee River and water ways surrounding the Project. This data will be regularly submitted to MDEQ and by extension, be available to USEPA. Note that adaptive management to water quality conditions is inherent in the NPDES Permit through MDEQ's authority to modify the permit as needed. Also note that the Mining Permit requires final WWTP design plans to be submitted for approval prior to construction (MP 01 2016 Special Permit Condition H3).

Non-Contact Water Management

Non-contact water, or storm water runoff, will be managed separately for the facility. During construction, storm water will be managed through the soil erosion and sediment control plan per the requirements of the Mining Permit (MP 01 2016 Special Permit Condition J). Once construction is complete, the SWPPP is implemented as detailed in the NPDES Permit (MI0059945).

Spill Prevention

Other measures to protect water resources include spill prevention, an important element in protecting surface water and groundwater. Spill prevention is addressed through the following plans and practices:

- Spill Prevention, Control, and Countermeasure Plan: required under Mining Permit Special Permit Condition B3/B4 and 40 CFR 112. The plan will address secondary containment, fuel delivery and dispensing activities, and potential storm water contamination from areas near oil storage. This plan will be stamped by a professional engineer.
- Pollution Incident Prevention Plan: required under Mining Permit Special Permit Condition B6. This plan will address a broad range of liquid and granular materials on site. It documents containment and practices that minimize the risk of spills.
- Cyanide Management Plan: required by Mining Permit Special Permit Condition E10. All cyanide materials used in the beneficiation processes will be managed in accordance with this plan. The plan will be developed to meet the objectives of the International Cyanide Management Institute's International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide. The Mining Permit requires the plan be certified by a professional engineer and submitted to MDEQ.

Potential Contamination from Air Emissions

The Part 632 Environmental Impact Assessment (EIA) (Foth, 2015a) includes an evaluation of potential contamination from air emissions. The evaluation considered potential impacts to water quality to the Menominee River and to Spring Lake, the smallest, northernmost lake associated with the Shakey Lakes area. This evaluation demonstrates that neither water body will show water quality impacts from Project emissions.

Groundwater Protection

Groundwater is protected by providing all reactive mine waste storage piles with appropriate liners. The liner specifications and designs are provided in the Mining Permit (MP 01 2016). Part 632 of Natural Resources and Environmental Protection Act (NREPA) of Michigan provides detailed requirements for liner design including use of a leak detection system. Final engineering plans and specifications and a Quality Assurance and Quality Control Plan are required to be submitted to MDEQ for approval prior to commencing construction of the mine waste storage areas (MP 01 2016 Special Permit Condition F3).

Once construction is complete, documentation of installation must be certified and submitted to MDEQ. This rigorous and documented set of requirements minimizes design, installation, and operation risks that might lead to leakage to groundwater. Monitoring, described below, is rigorous as well to maintain confidence in system integrity.

Impervious surfaces within the facility that prevent contact water from infiltrating to groundwater will be inspected and repaired under the requirements of MP 01 2016 Special Permit Condition K14.

Monitoring

A broad monitoring program is proposed and required under the Mining, NPDES, and Permit to Install (air permit). Monitoring is expected to be included under the wetland permit as well. Monitoring requirements contained in existing permits include but are not limited to:

- A network of groundwater monitoring wells around the facility structures in accordance with Mining Permit (MP 01 2016) and on a regional basis.
- A network of surface water stations monitoring for sediment, flow, and water quality.
- Wildlife monitoring that includes aquatic biota and terrestrial flora and fauna.
- Fish tissue analysis.

Surface water and groundwater monitoring have been addressed in the Mining Permit and the NPDES Permit. The surface water monitoring locations and parameter list are provided in the NPDES Permit Fact Sheet, Attachment 3.1. Groundwater monitoring wells serving the updated facility appear in Appendix B-10 of the Application and are presented in Attachment 3.2:

Figure 1 – Existing Monitoring Locations to be Abandoned for Project Construction

Figure 2 – Groundwater Quality Monitoring Well Locations (revised)

Figure 3 – Additional Groundwater Elevation Measurement Locations (revised)

Figure 4 – Wetland Monitoring Locations

Figure 5 – Postclosure Monitoring Well Locations (revised)

Groundwater monitoring locations will be positioned in accordance with Part 632 and specific requirements of the Mining Permit. The groundwater monitoring wells are to be confirmed upon review of a Mining Permit Amendment application. In general, wells are located to detect potential contamination from various activities, stockpiles, and mine waste facilities. Specific to wetland protection, Figure 2 shows the following groundwater monitoring wells in close proximity of specific wetlands and therefore indicators of potential wetland impacts:

Monitoring Well	Wetland
CW-3	WL-B1/B3
CW-5	WL-40
CW-6	WL-C1
CW-9	WL-A1
CW-10	WL-2B
CW-12	WL-6
CW-13	WL-14
MW-5	WL-A3

Evaluation of Potential Impacts to Menominee River from Reclaimed Mine

The evaluation of potential impacts on water quality in the Menominee River from the reclaimed mine was evaluated as part of the issuance of the Mining Permit (MP 01 2016). This is a state permit for the Project issued by the MDEQ under Part 632 of NREPA. That permit regulates

various aspects of the Project including mine waste storage facilities (as described above) and reclamation of the mine to protect groundwater quality in aquifers and by extension adjacent surface water systems.

The Mining Permit Application (Foth, 2015b) contained detailed waste characterization studies to assess the potential leachability of the waste rock that will be placed in the backfilled pit. The waste characterization studies complied with contemporary standards (ASTM, 2007; INAP, 2009; and Foth, 2015a). Those studies were used as a basis for development of project geochemical models of water quality (Foth, 2015a). The water quality models were similar to the methodology established for the permitted Eagle Mine. That methodology was selected since the Eagle Mine was permitted under Part 632, was litigated on this specific issue, and effectively set precedent in the state for assessing project water quality in the backfilled mine.

Table 3-1 in Attachment 3.3 summarizes the estimated concentrations in the backfill pore water of key constituents of concern. To assess impacts to the Menominee River, the flux of these constituents from the backfilled pore water were assumed to mix with groundwater where it could then migrate to the Menominee River. This assessment conservatively ignored attenuating transport reactions. As summarized in Table 3-1, the flux of constituents from the reclaimed mine to the Menominee River will not alter the baseline water quality as the projected concentration increases are so low as to be non-detectable under low flow conditions.

Comment #4: Secondary Wetland Impact Characterization

The application does not adequately characterize the proposed project's secondary impact on wetlands because it lacks information regarding the extent of wetlands that will be impacted by the project and how these wetlands will be affected by the proposed project's Menominee River drawdown of some 125,000 gallons per day.

Provide adequate characterization of wetland impacts, including any secondary wetland or stream impacts.

Response #4:

Detailed supporting information and discussion regarding the indirect wetland impacts was included in the recent responses to the January 19 and March 2, 2018, MDEQ letters (Foth, 2018a and Foth, 2018b). Those responses are summarized below.

- The term "upland wetland" was used simply to distinguish those wetlands in a higher topographic setting that appear to be entirely dependent on precipitation and surface water runoff (as compared to regional groundwater) based on hydrologic analysis. The term was used to distinguish those kinds of upland wetlands from wetlands that have a surface water level comparable to the regional water table, thus are dependent on groundwater sources as well as surface water and precipitation. Those wetlands are referred to in the permit application as "valley-bottom" wetlands.
- The responses to the two MDEQ letters referenced above contain supporting documentation for the wetland setting determination. Specifically, responses to Comments #3 through #7 in the January 19, 2018 letter (Foth, 2018a) and Comment #4.1 of the March 2, 2018 letter (Foth, 2018b) address the "upland wetland" setting. This

supporting documentation includes soil boring logs showing unsaturated soils, additional documentation of wetland piezometer and monitoring well hydrographs and cross-section details, and water balance modeling sensitivity analysis showing a surface water dominated system. The supporting documentation shows the regional water table to be positioned far enough below the ground surface at wetlands WL-14/14a/15b, 40/41, and B1/B1c/B3 so as to not have groundwater contributions from the regional water table to the wetland.

- The remaining ("valley-bottom") wetlands have some degree of communication with the regional water table. These wetlands are identified as valley-bottom wetland, and include WL-6 and the WL-2b/A1/A3 and the WL-C1 complexes. With the exception of the on-site portion of WL-6 (which will be under the facility footprint and therefore in the 'direct taking' category), these wetlands are located distant from the pit and are thus less susceptible to drawdown. For these wetland complexes, the combined effect of precipitation and runoff has been shown with multiple water balance modeling approaches (with conservative input values) and sensitivity analyses to be sufficient to compensate for the loss of groundwater input.
- An analysis of the hydrology of smaller, valley-bottom wetland lobes showed that the northern-most 1.93 acres of WL-A1 west lobe, and the southwestern-most 4.16 acres of WL-C1 lobe, could be impacted by changes to the wetland watershed and regional water table drawdown. The indirect impact to both wetlands was limited to the northern portion of WL-A1 and the southern portion of WL-C1. Regional water table drawdown predictions show that the drawdown of the regional water table at the property line would be approximately 0.5 feet for WL-A1 and WL-C1. The wetland water balance model shows that there is sufficient surface water to saturate the surface soils in the spring.

Regarding the explanation of the assessment of impacts, this was addressed in responses to Comments #8 and #9 in the January 19, 2018 MDEQ letter (Foth, 2018a). Those responses are summarized below.

- Wetland impacts were quantified by assessing the potential impairment by proposed Project activities on wetland hydrology. Wetland hydrology was selected because Project activities, such as pit dewatering (i.e., groundwater drawdown) and overall site grading (i.e., watershed alterations) may affect the wetland water budget and therefore have the potential to alter wetland hydrology. Changes in wetland hydrology could alter the wetland plant community by impacting species diversity and/or allowing upland species to colonize the wetland, and could influence the various functions and value (e.g., wildlife habitat) of the wetland.
- The hydrologic assessment of indirect impacts was supplemented with a semi-qualitative assessment due to "proximity." Further clarification of the use of a 50% watershed loss threshold in determining the impact of altering wetland watersheds due to proximity has been requested. Although there is a reference to a 50% threshold in the permit application documents, a single value of watershed alteration was not used. Indeed each wetland was analyzed with the annual and seasonal wetland water balance models using changes in the watershed size as one input value into the model. The 50% watershed loss

threshold was used as another metric in addition to the hydrologic analysis conducted with the water balance modeling. The watershed loss threshold, in addition to the semi-qualitative criteria of the wetland being surrounded on more than one side by the facility footprint, were used to define the indirect impacts by "proximity." This essentially amounted to a conservative safety factor of assessing potential wetland impacts above and beyond the results of the qualitative hydrologic analysis. The inclusion of the proximity assessment added another 11.08 acres of indirect impacts to the 6.09 acres of indirect impacts based on the hydrologic modeling assessment (for a total indirect wetland impact of 17.2 acres).

As a final comment on the assessment of potential indirect impacts, it should be reiterated that confirmation of the findings pursuant to the modeling can only be accomplished by wetland hydrology and vegetation monitoring during mining operations. As such, adaptive management measures, such as augmentation of wetland hydrology, will be considered based on monitoring results. The monitoring and adaptive management measures are discussed in the Proposed Wetland Monitoring and Adaptive Management Plan found in Appendix B-10 of the Application.

Regarding the comment that the Menominee River will be drawn down at a rate of 125,000 gallons per day (gpd), this was not the conclusion of our study. Groundwater inflow to the pit from the mine will be limited due to the construction of a bentonite-slurry wall. The estimate of 125,500 gpd (or 0.193 cubic feet per second [cfs]) of flow through the cut-off wall was a preliminary analytical estimate, which was stated as such in the cut-off wall memorandum. Regardless, that estimate was negligible compared with the 90-day, 10-year low flow estimate in the Menominee River of 1,370 cfs. Additionally, the wetland water balance modeling (used to assess indirect wetland impacts) was performed with the full water budget components, only one of which was related to the groundwater flow.

The issue of potential collection sump effects on adjacent wetlands was addressed in the response to Comment #2.4 of the March 2, 2018 MDEQ letter (Foth, 2018b). The sump operation will not impact groundwater levels near the mine waste storage areas. The analysis of the loss of watershed was included in the water balance modeling in Appendix A-1. Additionally, as documented in the monitoring plan in Appendix B-10 of the Application, extensive monitoring of the wetland hydrology and vegetation will take place in wetlands WL-C1 and WL-40/41.

The issue of potential indirect impact effects on adjacent wetlands due to dust deposition was addressed in the response to Comment #5.7 of the March 2, 2018 MDEQ letter (Foth, 2018b). The response concluded that wetlands will not experience accumulation of particulate, nor will wetland communities be impacted from dust deposition.

Comment #5: Alternatives Analysis

The application does not contain adequate support for the applicant's determination that offsite upland alternatives for some mine features (e.g., tailings storage) are not practicable.

Provide additional supporting documentation demonstrating that the preferred-alternative is the least environmentally damaging practicable alternative, e.g., documenting off-site alternatives for waste rock storage including cost-analysis.

Response #5:

Aquila acknowledges that USEPA's comments on the Least Environmentally Damaging Practicable Alternative (LEDPA) analysis is framed by Section 404 of the federal Clean Water Act (CWA) and the 404 Guidelines. As a threshold matter, however, Aquila believes USEPA's LEDPA review should also be informed by Part 303's specific finding that "the extraction and processing of nonfuel minerals may necessitate the use of wetland..." noted in Section 324.30302 (1)(d). Section 324.30311(4), while requiring that a thorough LEDPA-type analysis be performed as part of all wetlands permitting, also requires that the importance of mineral extraction be taken into account in evaluating the reasonableness of the impact to aquatic resources. The analysis should also be informed by Part 303's approach to factoring cost into the alternatives analysis. Section 324.30311(8) includes the idea that an alternative is not considered feasible and prudent if the projected cost of the alternative "is substantially greater than the costs normally associated with the particular type of project."

For the Back Forty Project, the rejected alternatives are either not economically feasible or not environmentally prudent (refer to LEDPA Table 4-1). These rejected alternatives are therefore unable to gain the support of investors and as a result cannot be constructed. Mining economics are largely driven by transport costs of mined material and water, which can render a project economically viable or unviable and which can greatly increase the greenhouse gas emissions associated with the project, fugitive emissions, and impacts to local roads and other infrastructure. Some impacts to the regulated wetlands immediately surrounding the mine pit are therefore unavoidable in terms of the following material transport costs:

- The continual hauling of waste rock from the mine pit to the mine waste storage areas during daily operations.
- The continual hauling of ore from the mine pit to the process plant during daily operations.
- The continual pumping of tailings from the process plant to the mine waste storage area east of the mine pit during daily operations.
- The continual pumping of water (between various on-site facilities such as the mine pit, contact water basins, mine waste storage areas, and process plant).
- Hauling of waste rock from the mine waste storage areas back to the mine pit at closure.

The preferred alternative was planned with the objective of maximizing use of upland areas, and avoiding direct impacts to (removal of) the on-site peripheral wetlands (WL-40/41, WL-C1, WL-A3, WL-A1, WL-2b) to the extent practicable. This is evident by the "work-around-wetland" design layout which compromises efficiency (from an ideal mine operation layout) in order to avoid these peripheral wetlands.

The preferred alternative does result in direct impacts to (removal of) portions of wetlands that immediately surround the mine pit (WL-6, WL-4a, WL-2c, WL-B2, WL-B1, and WL-52). Impacts to those wetlands are unavoidable for the Project to be economically feasible/viable as described in the Application documents.

The State-owned land east of the Project Boundary was considered as a potential off-site location for siting Project facilities such as tailings, waste rock, contact water storage, and ore processing (as part of Site Plan Alternative B described in LEDPA). The option was rejected because of the longer transport distances for waste rock, ore, and water which rendered the alternative economically infeasible and not optimal environmentally (more disturbance area and dust) or from a worker health and safety perspective. The State-owned land was also shown to contain wetland acreage that would need to be avoided, as shown in the National Wetlands Inventory wetland map on the MDEQ website. And although Aquila has mineral rights in the land to the east, those mineral rights do not give them any control over its surface use.

As described in Aquila's March 23, 2018 response to MDEQ (Foth, 2018b), the straight-line hauling distance from the center of the mine pit to the general vicinity of the process plant and mine waste storage area as currently proposed is approximately 3,000 feet for the preferred alternative; whereas the straight-line hauling distance to the off-site, State-owned land to the east is approximately 10,000 feet. A typical hauling cost for ore and waste rock is assumed to be approximately \$0.50 per ton per 1,000 feet. For the approximate total quantity of ore and waste rock expected for the Back Forty Project (totaling approximately 60 million metric tons), the total transport cost as currently proposed will be approximately \$90 million. If the mine waste storage area and contact water basin were located on the State-owned land to the east with the resultant hauling distance thereby increased to 10,000 feet, the hauling costs would increase to approximately \$300 million. The costs to relocate the waste rock back to the mine pit at closure would be similar, so effectively increasing the total for transportation costs on the Project from approximately \$180 million to \$600 million. And if the contact water basins were also to be located on the State-owned land, pumping costs would also increase significantly.

A typical net present value expected for a mining project similar to the Back Forty Project would be on the order of \$250 million. Therefore, the additional operational transport costs for ore, waste rock, and water of over \$250 million would certainly result in a negative net present value, and therefore result in an economically infeasible project. From an overall "environmental footprint" perspective, to spread out the mine operation (as compared to consolidating it as currently proposed) by building a haul road to a site at least 4,000 feet further east would result in both direct additional landscape impacts as well as secondary or indirect impacts to otherwise relatively undisturbed parcels.

Comment #6: Wetland/Upland Preservation and Statutory Requirements

The application has not provided needed information to determine whether some 500 acres of wetlands and uplands that were selected for preservation meet statutory requirements to be used as wetland and stream mitigation.

Provide additional support documentation demonstrating that the proposed preservation area meets the requirements of the 2008 Federal Mitigation Rule.

Response #6:

In 2008, the USEPA and the USACE jointly promulgated regulations under 40 CFR Part 230, titled Compensatory Mitigation for Losses of Aquatic Resources. These regulations define compensatory mitigation as the restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of wetlands, streams, and other aquatic resources for the purposes of offsetting unavoidable adverse impacts after all appropriate and practicable avoidance and minimization has been achieved. These regulations identify methods of compensatory mitigation, in order of preference, to include mitigation banks, in-lieu fee programs, and permittee-responsible mitigation.

The Mitigation Plan (pages 5-8) (see Wetlands Permit Application, Section 8) describes options considered to compensate for unavoidable wetland impacts from the Project. Permittee-responsible mitigation was selected as the preferred mitigation option because mitigation banks are not available for this watershed or ecoregion under provisions of Michigan's wetland and stream regulations. In addition, neither in-lieu fees nor enhancement of existing wetlands are mitigation alternatives that MDEQ can consider. Preservation of a 507.74-acre parcel located approximately six miles from the Project site was considered the preferred mitigation option after an evaluation of on-site, near-site, and off-site options for a large wetland restoration project to mitigate for the approximate 28 acres of impact on the Project site. The selected mitigation site provides a unique opportunity to preserve a large tract of undeveloped land, under demonstrable threats, with approximately 4,794 linear feet of Menominee River frontage and a combination of aquatic, wetland, and upland buffer habitats which provide high quality aquatic value and function to the Menominee River and its watershed. In appreciation for the concerns as to a lack of a traditional mitigation plan associated with wetland creation through restoration, an additional updated search of prospective pre-settlement wetland sites currently being farmed in the watershed is being conducted and Aquila will provide MDEQ and USEPA with the results of that search within the next few weeks. However, please note that there is a small but important component of the current mitigation/preservation plan that does provide for some restoration of wetlands in that it incorporates the removal of existing, filled two-tracks through wetlands (and scattered on-site debris) that will account for more than one acre of wetland restoration. Particularly as it relates to the removal of filled roadways, the benefits of such removal/restoration will be more than just a specific acreage of wetland, it will reclaim the pre-development continuity in the wetlands on either sides of the current roadways, so as to eliminate any secondary effects that those existing roadways might have on wetland functions and values since their construction decades ago.

The Mitigation Plan (Tables 4, 5, and 6) provides a comparative summary of the Project impacts and the proposed associated compensatory mitigation. The mitigation site contains approximately 294.24 acres of wetland preservation, approximately 12,833 linear feet of aquatic habitat (associated with the riparian corridor of the Menominee River and tributary streams) for mitigation/preservation, and approximately 213.5 acres of adjacent upland buffer. This preservation plan is therefore intended to mitigate the potential Project impacts of approximately 28 acres of wetland (as provided for by both Michigan and Federal Mitigation Rules) and to mitigate for approximately 253 linear feet of stream impacts associated with the Project.

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Foth Infrastructure & Environment, LLC • 13

Ancillary benefits from removing structures/debris, managing invasive plant species, limiting uses through a conservation easement, and implementing long-term management plans, while not formally "creditable" by state of Michigan Statutory Rules or MDEQ guidelines, will assist in the preservation of these high quality aquatic habitats in perpetuity.

Comment #7: Response Letters

We note that the applicant has not provided the information requested by MDEQ in Letters of January 19, 2018, and March 2, 2018. Responses to these letters should significantly clarify outstanding concerns regarding the application.

Provide complete responses to the questions concerns outlined in MDEQ's January 19, 2018 and March 2, 2018, letters.

Response #7:

Since the date of the USEPA letter, Aquila has submitted a response to MDEQ's letters. The response to the January 19, 2018 letter was submitted to the MDEQ on March 9, 2018 (Foth, 2018a) and a response to MDEQ's March 2, 2018 letter was submitted to the MDEQ on March 23, 2018 (Foth, 2018b). Both response documents have been posted to the MiWaters website and are available to the USEPA through the MDEQ.

Miscellaneous Comments from USEPA Letter Enclosure

These comments appear in the USEPA letter enclosure and were not included with the summary comments. In an effort to address all comments comprehensively, responses are provided below.

Adaptive Management

To address the suggestion that the Adaptive Management Plan should include specific adaptive management metrics and impact thresholds, Aquila is proposing the following:

Establish Off-Site Control/Reference Wetlands

Up to six off-site control/reference wetlands could be established in 2018 in consultation with MDEQ. Ongoing access to these wetlands will be dictated by off-site landowners who would allow such activities, e.g., Michigan Department of Natural Resources. The data collected would include an established baseline and continue over the life of mine, focusing on comparative hydrology. Potential wetlands to be used for this purpose would be identified and proposed to MDEQ for a determination as to the appropriateness of their use as control/reference areas. The wetlands would be well outside of potential influence from the Project and other significant interferences. Piezometers would be installed in each wetland and data would be regularly collected of near-surface water levels throughout the growing season. Vegetation surveys would be included.

Identify Thresholds

Identification of a Project-related impact (threshold) would be based on a comparison of the on-site and off-site hydrology data to the appropriate baseline data. A threshold may be met if during the growing season there is a 6 inch or greater decrease in the near surface water table elevation compared to the near surface water table elevations being monitored in control/reference wetlands.

The threshold would be further supported with monitoring data on wetland plant community changes. Each on-site wetland has baseline data established in accordance with MDEQ Wetland Identification Program. Pre-construction vegetative data will also be collected in 2018 in accordance with the proposed "Wetland Vegetation Assessment Reporting" as outlined in Appendix B-10. Over the life of mine, a change to the average "Wetland Indicator Number" index value for a sample point exceeding 2 in any individual wetland will be considered a threshold. Additionally, should an individual wetland with an average "Wetland Indicator Number" index value of zero or less develop an average score greater than 0, this will be considered a threshold of impact for that wetland.

Regarding the verification that augmentation would be a "viable long-term strategy," Aquila proposes the following:

Augmentation of near surface wetland hydrology would be implemented by the installation of a multi-outlet pumping/irrigation system, using the Menominee River as a water source. Subject to MDEQ review and approval, the implementation would likely involve the placement of an irrigation system in the upland areas immediately adjacent to each potentially impacted wetland. Appropriate volumes of water (as determined by MDEQ) would be discharged evenly around any given wetland, most likely early in the growing

season in such a manner as to recharge the near surface waters and imitate natural/pre-operation conditions.

<u>Endangered Species – Northern Long-eared Bat</u>

Myotis septentrionalis, the northern long-eared bat, is potentially at the site as noted. Mining Permit MP 01 2016 Special Permit Condition B11 requires Aquila to conduct a bat survey prior to construction by a qualified biologist. The results will be submitted to the MDEQ and be used to assess potential impacts from mine construction or operations. The USFWS recommends that clearing trees in preparation for construction can be conducted between October 1 and March 31 to minimize any effects to the bats.

<u>Trust Responsibility Species – Lake Sturgeon</u>

Lake Sturgeon (*Acipenser fulvescens*) in the Project vicinity are documented in the environmental baseline studies contained in the EIA (Foth, 2015a). Aquila recognizes the concern over maintaining the population and restoration efforts. As provided in this document and previous submittals, the permits for the Project and their requirements concerning the protection of groundwater and surface water are designed so that water quality standards (which are protective of sturgeon and other aquatic species) will be met at all times. Other than the NPDES discharge to the Menomonee River, the Project requires no activities in the river that would alter sturgeon habitat.

Cultural and Archeological Resources

Aquila conducted extensive research and archaeological surveys of the Project Area as part of the Part 632 permitting process. The surveys identified some cultural resources, but none of the identified resources will be disturbed by the proposed mining activities. Specifically, no burial sites or mounds will be disturbed. In fact, the Project has been designed so that no burial sites or mounds are located within the Project's fenced area. Further, Aquila has prepared an unanticipated discovery plan in the event that additional resources are encountered as the Project moves forward. The preparation of such a plan is required under Special Permit Condition A2 of the Mining Permit (MP 01 2016). Documentation on cultural resource issues has been provided to the MDEQ as part of the Application.

Aquila's survey reports were provided to and reviewed by the State Archaeologist, who also visited the Project site. Aquila requested information from tribes in the general vicinity of the Project about properties of cultural or religious significance to them, and met with Menominee and Hannahville representatives at the Project site to discuss cultural and environmental concerns, as well as the results of the archaeological surveys. Aquila provided the survey reports to the Menominee and Hannahville tribes. Aquila provided USEPA a Tribal Engagement Summary last year detailing communications between Aquila and the Menominee Tribe, as well as other tribes, in an effort to address tribal concerns about cultural resources. More recent correspondence is included in Foth (2018b).

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Attachment 2.1 Menominee River Bank Geotechnical Stability Analysis



TECHNICAL MEMORANDUM

DATE April 5, 2018

Project No. 1671468 (Phase 3000, Doc #1)-Rev 2

TO Andrew Boushy, Senior Vice President, Capital Projects

Aguila Resources Inc.

CC Steve Donohue, Foth Infrastructure & Environment, LLC

FROM Kebreab Habte and Ken Bocking

EMAIL khabte@golder.com

MENOMINEE RIVER BANK GEOTECHNICAL STABILITY ANALYSIS BACK FORTY PROJECT, MICHIGAN

1.0 PURPOSE

The Back Forty project being proposed by Aquila Resources Inc. in Michigan is situated adjacent to the Menominee River. This technical memorandum is prepared in response to a request by the United States Environmental Protection Agency (USEPA 2018) for additional documentation related to the slope stability of the Menominee River bank. The results of the slope stability analyses carried out on a critical cross-section of the river bank under an average water level, 100-year flood water level and 1,000-year flood water level are presented in this technical memorandum.

2.0 BACKGROUND

2.1 Site Description

The proposed open pit of the project is approximately 50 to 70 m away from the Menominee River as shown in Figure 1. It is proposed to construct a 400 m long cut-off wall between the river bank and the open pit to reduce seepage from the river into the open pit.

The site gently slopes towards the Menominee River. The top elevation of the river bank varies from 214 m to 215 m. The bank is approximately 8 m high. The side slopes of the bank vary from 1.6-1.7 Horizontal (H): 1 Vertical (V). As shown in Appendix A, the bank slopes are covered with mature trees, shrubs and grasses with no sign of erosion or instability. The presence of a diverse vegetation cover significantly reduces the likelihood of shallow bank erosion and instability.

2.2 Geotechnical Investigations

A number of geotechnical investigations have been carried out in the vicinity of the river bank to support the design of the cut-off wall and the open pit slope. The boreholes close to the river bank are shown in Figure 1. In these boreholes, the thickness of the overburden overlying the bedrock varied from 11.3 m to 20.9 m. The overburden soil consisted of loose to very dense silty sand to sand and gravel. Pockets of cobbles were also encountered in some of the boreholes. The grain size distribution of the overburden soils are shown in Figure 2. Based on these results, the overburden consisted of up to 55% gravel, 36-96% sand, and 2-41% fines. The content of clay-sized particles was typically 12% or less.

Golder Associates Ltd. 6925 Century Avenue, Suite #100 Mississauga, Ontario, L5N 7K2 Canada

T: +1 905 567 4444 | F: +1 905 567 6561

golder.com

The water table was encountered within the overburden soil, on average 6.4 to 8.6 m below ground surface and varied in elevation from 206.3 to 207.9 m as shown in Figure 1. The moisture content of the overburden varied between 3.1% and 12.6%.

The measured 'N' values from the Standard Penetration Testing (SPT) of the overburden soil varied between 3 and 12 blows per 0.3 m penetration for the first 10 m and increased thereafter with depth to more than 80 blows per 0.3 m penetration near the contact with the bedrock. The measured SPT values were corrected for a number of factors as discussed in 3.5. The plot of the corrected SPT 'N' values are presented in Figure 3.

As shown in Figure 4, the hydraulic conductivity measured in the overburden soil ranged from 3.6×10^{-5} m/s to 1.0×10^{-7} m/s, with a geometric mean of 1.3×10^{-5} m/s. The hydraulic conductivity measured in the weathered bedrock ranged from 4.4×10^{-7} m/s to 8.4×10^{-9} m/s, with a geometric mean of 1.4×10^{-7} m/s.

2.3 Site Seismicity

The Project is located in an area of low seismicity. The site Peak Ground Acceleration (PGA) is estimated according to the U.S. Geological Survey - 2015 National Earthquake Hazards Reduction Program (NEHRP) Provisions. The estimated PGA for return periods of 1 in 475 years and 1 in 2,475 years are 0.01g and 0.034g, respectively.

3.0 SLOPE STABILITY ANALYSIS OF MENOMINEE RIVER BANK

3.1 Critical Cross-Section

Three cross-sections shown in Figure 1 were considered for the river bank slope stability analysis. Section 2 was used in the stability analysis it was the most critical of the three cross-sections considered. The subsurface stratigraphy was assigned based on the geotechnical boreholes immediately adjacent to the cross section. The subsurface stratigraphy of the cross section was presumed to extend under the river bed. It was conservatively assumed that the river had eroded to a thalweg corresponding to the top of bedrock and then subsequently infilled with alluvium to its current river bed level.

3.2 Menominee River Water Elevations

The water level and flows in the Menominee River are regulated as there are a series of dams and reservoirs upriver and downriver from the project site. White Rapids Dam is the nearest control structure located approximately 2.9 km upriver from the project site.

The slope stability of each cross-section was evaluated during the average-year, 100-year and 1,000-year flood water levels in the Menominee River.

The average-year water level was conservatively assumed to be at the river bed. The 100-year flood elevation in the vicinity of the project site is estimated to be 211.7 m based on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM). Foth (2016) estimated the difference between the 100-year and 1000-year flood elevations to be 0.7 m. Therefore, the 1,000-year flood elevation is assumed to be 212.4 m.

3.3 Surcharge

A 40 kPa surcharge is assumed on top of the river bank. The surcharge represents the cut-off wall construction equipment as well as other mine fleet traffic.



3.4 Geotechnical Parameters

The geotechnical parameters assigned for the various materials in the cross-section are summarized in Table 1. The sources of these parameters are described in the following sections.

Based on conditions observed in previous geotechnical investigations (Golder 2011 and KP 2016), the overburden was divided into two layers. The top part of the overburden is loose and the bottom part of the overburden is dense. The thickness of the two overburden soil layers under the cross-section was estimated based on the nearest borehole data. The Menominee River is assumed to be underlain by a loose sediment above the bedrock.

Table 1: Geotechnical Parameters used in Stability Analyses

Material		Model	Unit Weight, γ (kN/m²)	Friction Angle, ϕ^* (Degrees)	Cohesion, c' (kPa)	Saturated Hydraulic Conductivity, k _{sat} (m/s)
Overburden	Upper	Frictional	20	33	0	1.3 x 10⁻⁵
	Lower	Frictional	21	38	0	
Assumed alluvium river bed		Frictional	18	28	0	1 x 10 ⁻⁵
Cut-off-wall		Undrained (Phi=0)	12	0	50	1 x 10 ⁻⁸
Weathered Zone		Bedrock (Impenetrable)		*	*	1.4 x 10 ⁻⁷

The unit weights of the various materials were based on site-specific geotechnical investigation data and Golder's experience with similar materials.

Strength of the overburden soils were estimated using the SPT test results. The measured SPT values were corrected for the effect of the energy delivered to the drill rod (ER_r/60), overburden stress (C_N), length of the drill rod (C_r), sampler liner effect (C_s) and the borehole diameter (C_d) using the expression below:

$$(N_1)_{60} = N \frac{ER_r}{60} C_N C_r C_s C_d$$
 [1]

The correlation recommended by the Canadian Foundation Engineering Manual (CGS, 2006) was used to estimate the overburden correction factor:

$$C_N = 0.77 * log_{10} \frac{1920}{\sigma_n^{\prime}}$$
 [2]

The peak friction angle ϕ ', was estimated from the SPT data using the Kulhawy and Mayne (1990) and Hatanaka and Uchida (1996) methods. These methods are based on the expressions below:

$$\phi' = tan^{-1} \left[\frac{N}{12.2 + 20.3 \left(\frac{\sigma_{y_0}}{P_{x_0}} \right)} \right]^{0.34}$$
 (Kulhawy and Mayne, 1990) [3]

$$\phi' = \sqrt{20(N_1)_{60} + 20}$$

(Hatanaka and Uchida, 1996)

[4]

where.

N = uncorrected SPT count:

 $(N_1)_{60}$ = corrected SPT count;

 σ_{vo} ' = vertical effective stress; and

P_a = reference stress equal to 1 atmosphere.

Figure 5 illustrates the estimated friction angles of the overburden soils. The figure shows that the friction angle is generally higher than 30° for the top overburden soil, with a high degree of variability. The minimum friction angle increases to 35° for the bottom overburden soil. The very high friction angles inferred from the methods above are due to the high N values caused by the presence of gravels in the soil. For the stability analyses, friction angles of 33° and 38° were conservatively assumed for the top and bottom overburden soils, respectively.

An undrained shear strength of 50 kPa was conservatively assumed for the cut-off wall. For the assumed alluvium in the river bed, a friction angle of 28° was assumed, this being typical for a loose silty material.

The hydraulic conductivities of the overburden soils and the weathered bedrock were based on field permeability test results as discussed in Section 2.2. The cut-off wall was assumed to have a hydraulic conductivity of 1x 10-8 m/s.

3.5 Method of Slope Stability Analyses

The slope stability analyses were carried out using SLOPE/W, a two-dimensional limit equilibrium program, contained in the GeoStudio 2018 software developed by GEO SLOPE International, Ltd. The Morgenstern Price method of analysis was used, where the interslice shear forces were represented with a half sine function. Slope stability was checked for different slip surfaces (i.e. grid and radius, entry and exit and auto locate search method).

The Factor of Safety (FoS), defined as the ratio of the forces resisting failure over the forces tending to cause failure, was computed for numerous potential failure surfaces and the lowest FoS which has the potential to cause a relatively deep seated failure was chosen as the critical FoS. (FoS results related to ravelling along the surface of the bank were considered trivial.)

The phreatic surface in the slope stability analyses were imported from seepage models prepared using the SEEP/W package in GeoStudio 2018.

3.6 Loading Conditions

The stability analyses were carried out under both static and pseudo-static (earthquake) loading conditions. A PGA value of 0.034g, which corresponds to a return period of 1:2,475 years, was used for the pseudo-static stability analyses.

3.7 Results of Slope Stability Analyses

Deep seated slope stability analyses were carried out through cross-section 2 to assess failure surfaces that passes through the cut-off wall. The results of the stability analyses are summarized in Table 2 and presented in Figure 6. The minimum static FoS of the deep seated failure varied between 4.11 and 4.33, and the minimum pseudo-static FoS varied between 3.26 and 3.28. The blasting operation near the river bank will be controlled to reduce the potential impact on the river bank and the cut-off wall. Therefore, blasting will not have significant impact on the

slope stability as it will generate much lower PGA than what was used in the pseudo-static analysis. The results confirm the low probability of deep-seated failure that compromise the performance of the cut-off wall.

Table 2: Results of Deep-seated Slope Stability Analyses

River Condition	Minimum Static FoS	Minimum Pseudo-Static FoS
Dry	4.11	3.27
100-year flood	4.26	3.26
1,000-year flood	4.33	3.28

4.0 CONCLUSIONS

- The results show that potential deep-seated failures that would compromise the performance the cut-off wall are very improbable. From all the scenarios evaluated, the minimum static and pseudo-static FoS were 4.11 and 3.26, respectively.
- The blasting operation near the river bank will be controlled (e.g. with programmed delays) to reduce the potential impact on the river bank and the cut-off wall. A blast monitoring program will be implemented to confirm that peak particle velocities stay within target values.
- Engineering contingency measures are available if toe erosion results in areas of shallow instability in the river bank during operation. The engineering measures may include placement of rip rap, toe berms, gabion baskets or groins to deflect flow away from the toe of the bank.

Golder Associates Ltd.

Kebreab Habte, M.Sc. (Eng.), P.Eng. (ON)

Senior Geotechnical Engineer

Ken Bocking, M.Sc., P.Eng. (ON) Principal

DB/KBH/KAB/sk

Attachments: Figures 1 to 6

Appendix A - River Bank Vegetation Photos

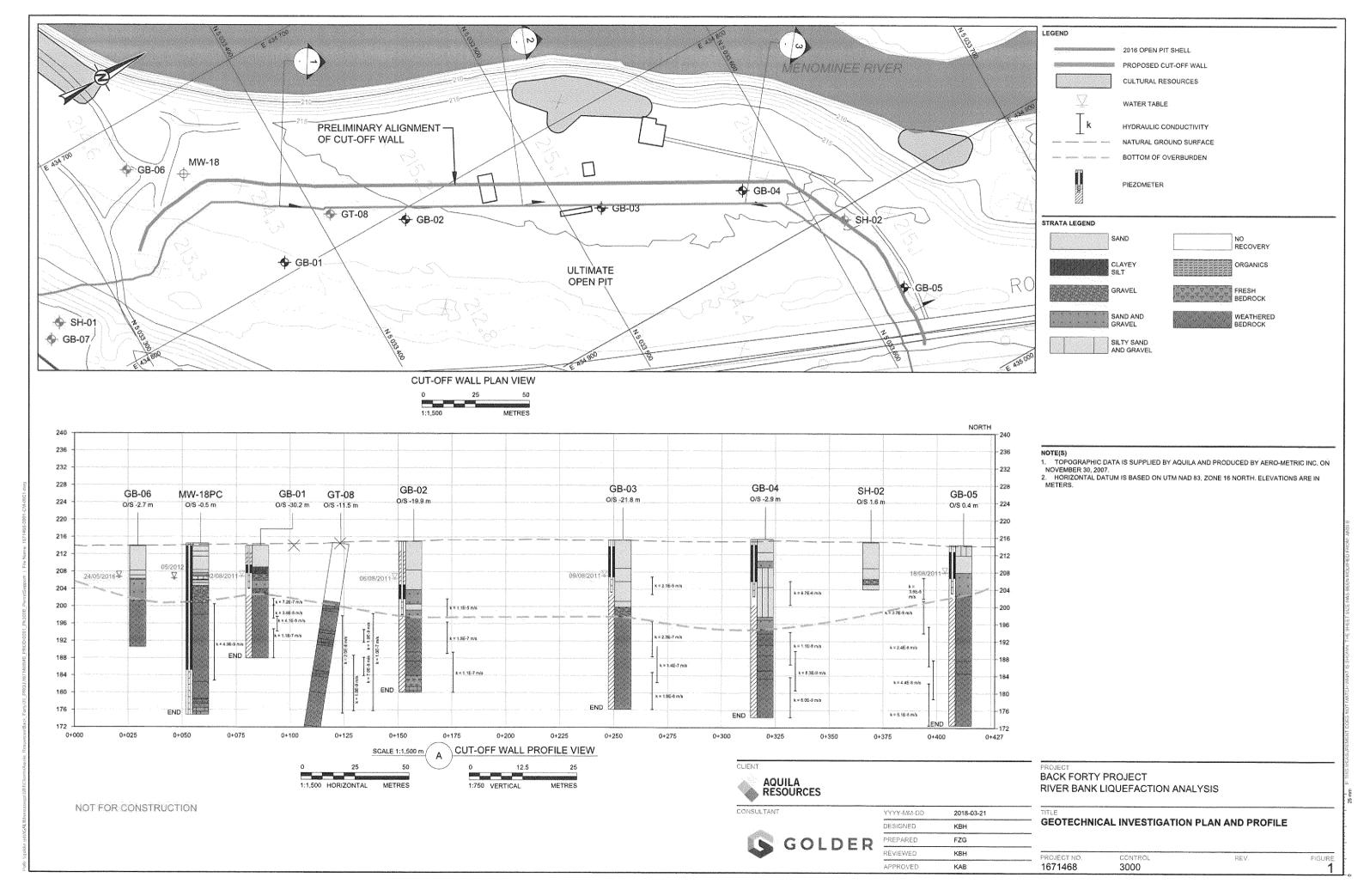
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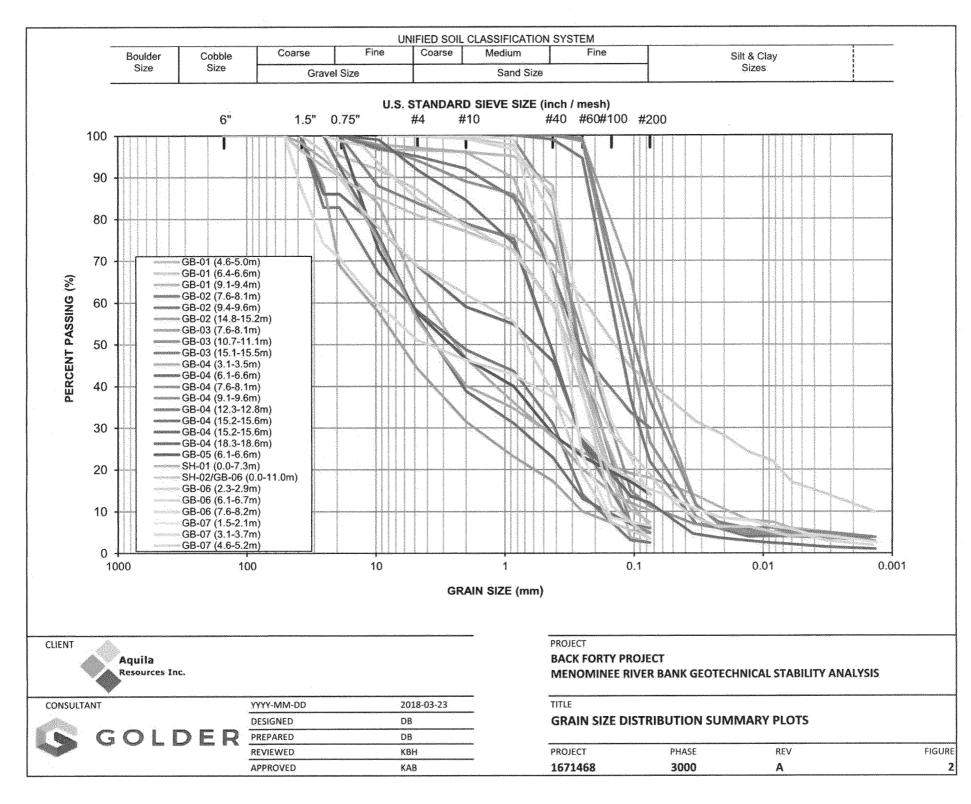


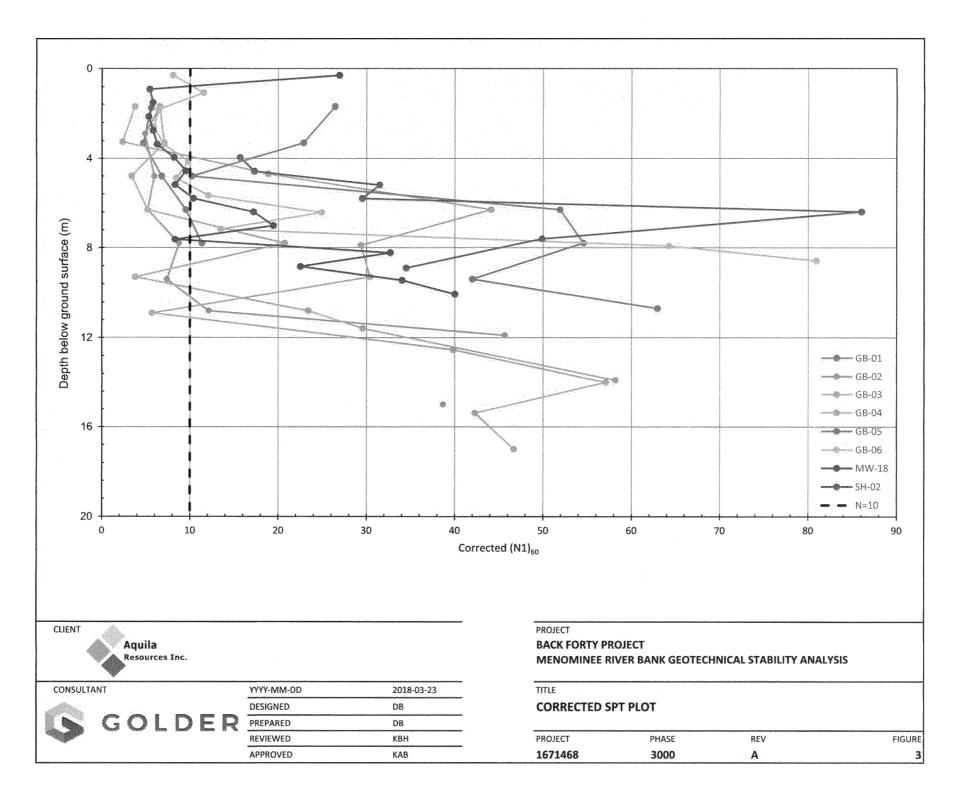
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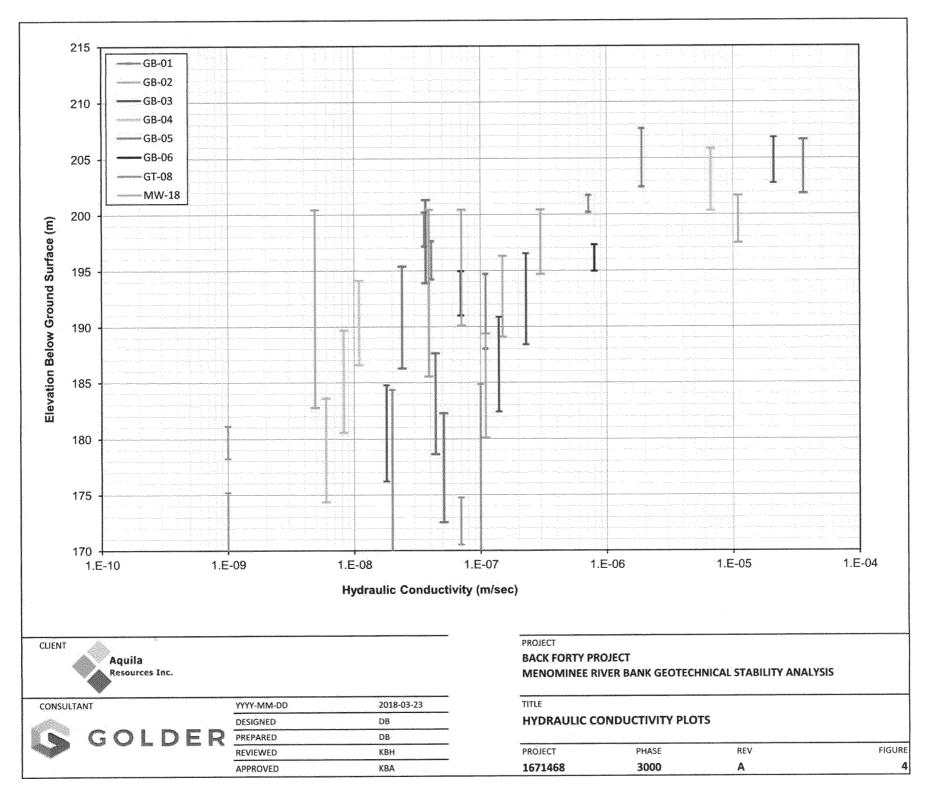
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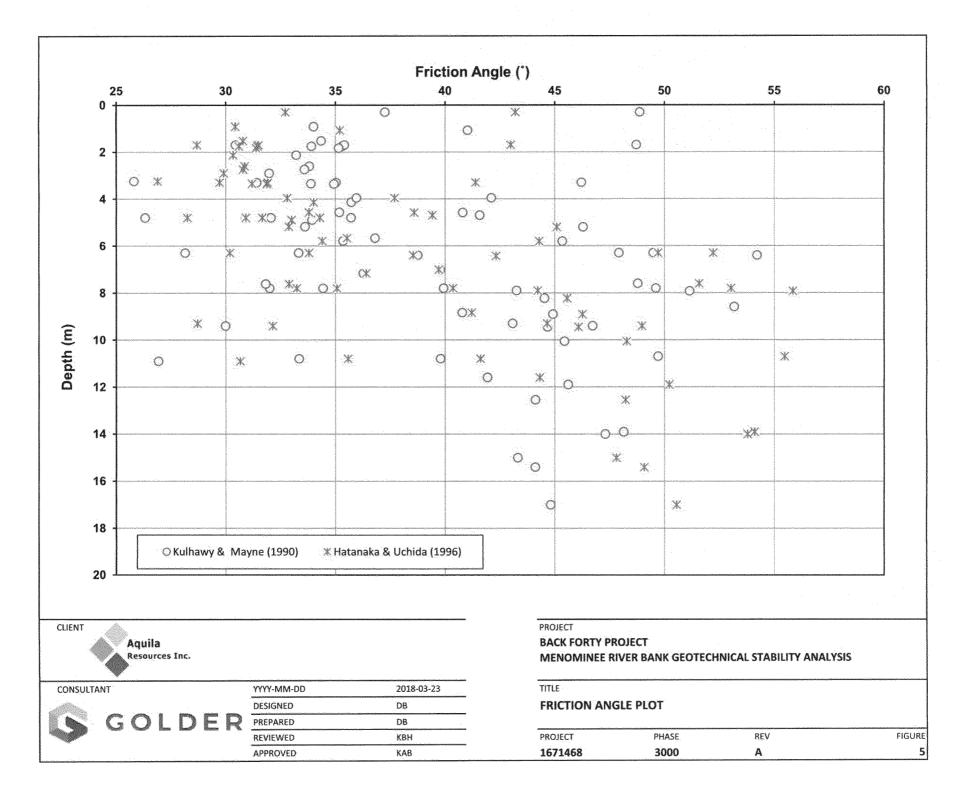
FIGURES

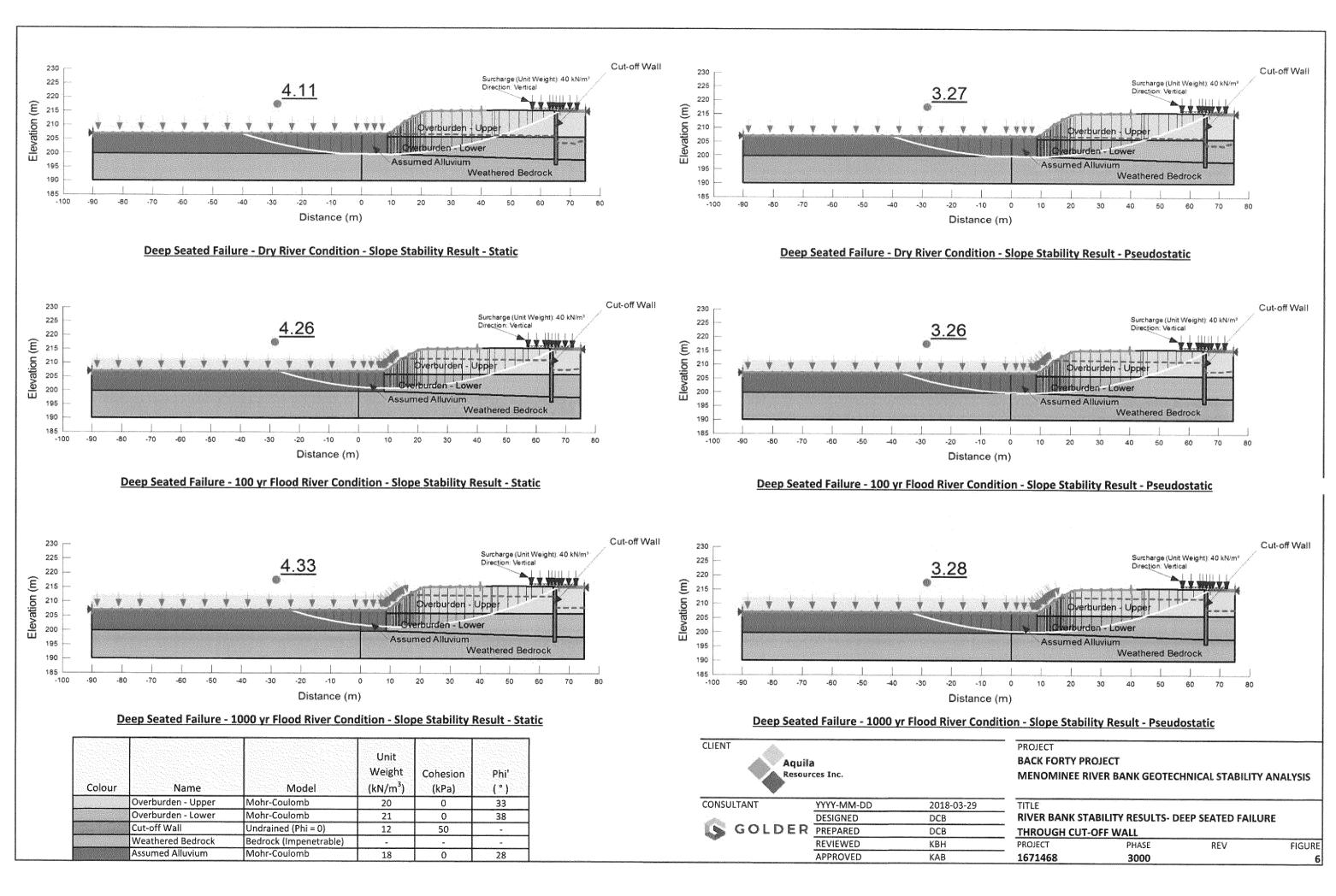












APPENDIX A River Bank Vegetation Photos



Photo 1: Photo showing vegetation along the riverbank of the Menominee river (Foth).

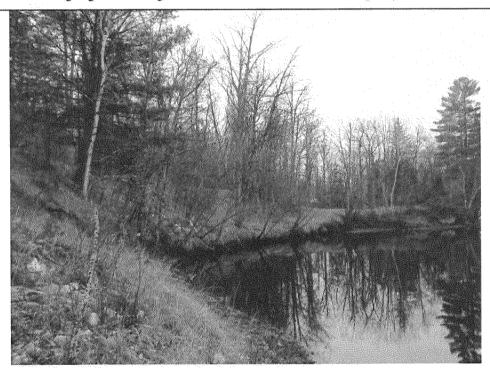


Photo 2: Photo showing vegetation along the Menominee river bank (Foth).



Photo 3: Photo looking east at the Michigan shoreline at AQ2, transect A of the ERM Aquatic Biota Report (ERM, 2010).



Photo 4: Photo looking east at the Michigan shoreline at AQ2, transect F of the ERM Aquatic Biota Report (ERM, 2010). Photo is south of the proposed cut-off wall location.



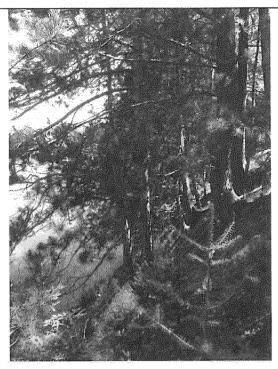


Photo 5: Photo looking the Michigan shoreline at near the south end of the proposed cut-off wall location (Golder, 2016)

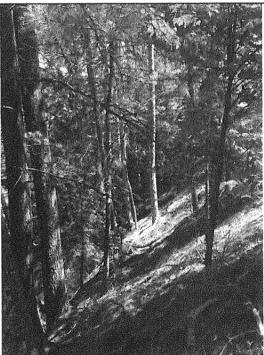


Photo 6: Photo looking the Michigan shoreline near the south end of the proposed cut-off wall location (Golder, 2016).



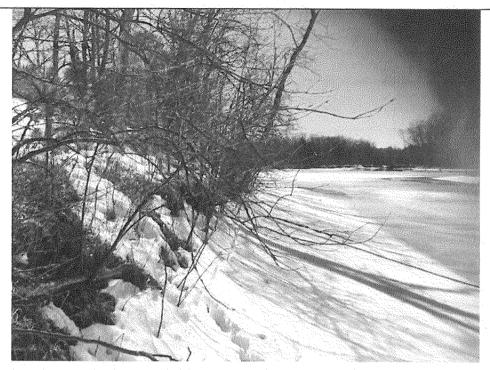


Photo 7: Photo looking south at the Michigan shoreline near the north end of the proposed cut-off wall location (Aquila, 2018).

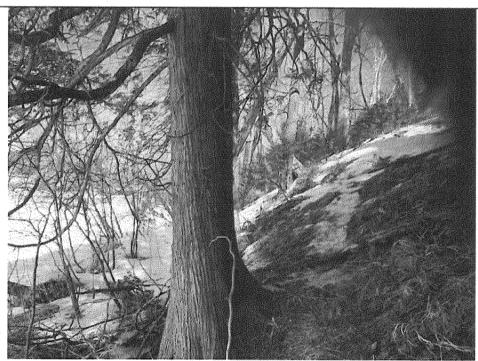


Photo 8: Photo looking north at the Michigan shoreline near the north third of the proposed cut-off wall location (Aquila, 2018).



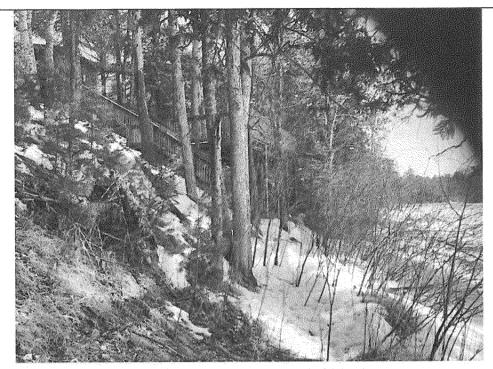


Photo 9: Photo looking south at the Michigan shoreline near the north third of the proposed cut-off wall location (Aquila, 2018).

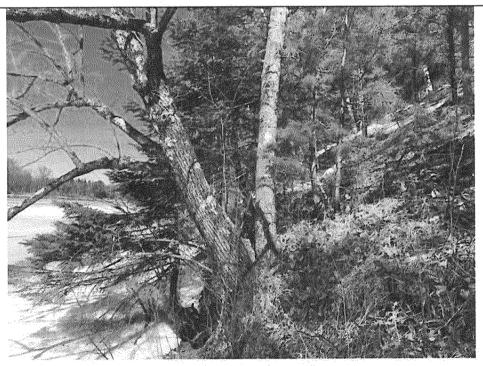


Photo 10: Photo looking north at the Michigan shoreline near the middle of the proposed cut-off wall location (Aquila, 2018).





Photo 11: Photo looking south at the Michigan shoreline near the middle of the proposed cut-off wall location (Aquila, 2018).



Photo 12: Photo looking south at the Michigan shoreline near the south end of the proposed cut-off wall location (Aquila, 2018).

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References:

Environmental Resources Management (ERM) (2010), Aquatic Biota Report, Environmental Baseline Studies. Aquila Resources Inc. Back Forty Project, October 2011. Prepared by Environmental Resources Management, October 2010.



Attachment 2.2 Menominee River Historical Channel Migration



TECHNICAL MEMORANDUM

DATE March 29, 2018

Project No. 1671468 (Phase 3000, DOC #2)

TO Andrew Boushy, Senior Vice President, Capital Projects, Aguila Resources Inc.

CC Steve Donohue, Foth Infrastructure & Environment, LLC

FROM Kebreab Habte

EMAIL khabte@golder.com

MENOMINEE RIVER HISTORICAL CHANNEL MIGRATION BACK FORTY PROJECT, MICHIGAN

1.0 INTRODUCTION

The Back Forty project being proposed by Aquila Resources Inc. in Michigan is situated adjacent to the Menominee River. This technical memorandum is prepared in response to an additional documentation request by the United States Environmental Protection Agency (USEPA 2018) related to the potential for river erosion to impact the open pit component of the project during the operational years.

To address this request, an overview analysis of river channel stability and bank erosion was carried out on the Menominee River to assess the potential hazard to the proposed open pit from river channel bank erosion. The analysis consisted of a review of historical aerial photographs, spanning 78 years (1938-2016), to document and compare the historical location of river features such as river banks, islands, and old escarpments, as well as interpreting the alignment of the river thalweg

2.0 PROJECT SETTING

The Back Forty project and open pit is situated on the east bank of the Menominee River approximately 2.9 km downstream of the White Rapids dam. The presence of the White Rapids dam, built in the late 1920's, means the river is hydraulically regulated and likely in a sediment transport equilibrium different than the natural equilibrium. This difference is likely related to the sediment trapping effect of dams and the potential for increased scour downstream of dams as river discharge entrains bed materials.

3.0 METHODS

A photographic comparison of the river 2 km upstream and downstream of the project site, using archived images from Google Earth and the US Department of Agriculture in the years 1938, 1998, and 2016, was carried out in the following ways:

- Comparing the bank and island locations for the 3 select years;
- Comparing the location of the thalweg through the project area for the 3 select years; and
- Analysing the location of the river bend in 2016 (meander band width analysis).

The US Department of Agriculture image (1938) was georeferenced to the Google Earth images through alignment of common features near the project site (i.e. Squaw Creek Rd. and houses). The location of the thalweg in each image was determined through qualitative interpretation and in select spots informed with

Golder Associates Ltd. 6925 Century Avenue, Suite #100 Mississauga, Ontario, L5N 7K2 Canada

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measured bathymetry. In the 2016 image the location of the historic river bends were identified through an analysis of the cross sectional elevation profile in Google Earth.

During the historical period covered by the three archived images (1938 – 2016), a range of flows occurred that include events that exceed the 100 year flood. Figure 1 shows the annual maximum flows at the USGS station 04066800 - Menominee River at Koss, Michigan (approximately 22 miles downstream of the project site). In 1960, a flood event occurred with a maximum discharge of 33,000 cfs. According to the frequency analysis performed by Foth (2016), this flow rate exceeds the 200 year flow event.

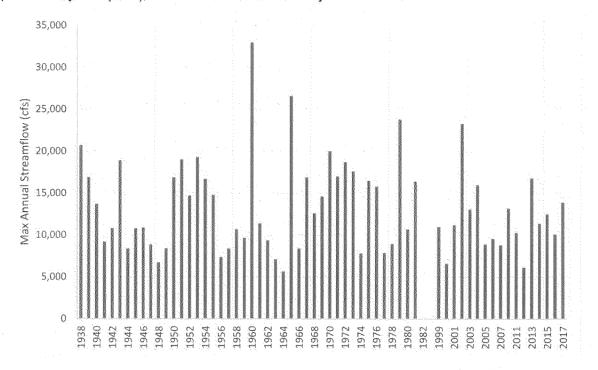


Figure 1: Annual Maximum Flows recorded at Menominee River at Koss, Mi (1938 - 1981, 1999 - 2017)

4.0 RESULTS

4.1 River Setting Observations

Below White Rapids dam and through the project site the river appears to be single to multi-threaded with meandering channels flowing around mid-channel islands. The river has a low gradient: the total drop in hydraulic head from just below the dam to the project site is approximately 2.5 m and the average river gradient is approximately 0.06%. The terrain around the river is rolling to hummocky, with elevation changes commonly of no more than 30 m. Relict terraces and old meander scars are present along the river margin indicating the occurrence of lateral channel migration over the post-glacial period (e.g. last 10,000 years). A relict terrace is an old floodplain that has been formed by past fluvial processes but is no longer actively worked on by the river. The meander scars appear to be confined to the western bank of the river, the bank on the opposite side from the project. The relict terraces are observed on both sides of the river. The proposed open pit extends into one of these relict terraces: the minimum surface elevation of the terrace is above the 700 foot contour (approximately 213.4 m), the 100-year flood elevation has been estimated to be 695 feet (approximately 211.7 m).

The planform of the river appears to consist of pool and riffle sequences, with deep and shallow areas. A series of shallow water rapids can be observed at the upstream end of several of the island clusters and these may



be inferred to be bedrock related. In rivers, pools form typically on the outside of river bends (meanders) and riffles form in the straight channels between the bends and in constrictions where the flow is faster. Additionally, the riverbank along the outside part of a meander in a river that has a wandering channel is typically where the steepest bank is located and typically where the greatest erosion occurs. The majority of the open pit and cut-off wall are situated adjacent to a straight section of river where a mix of erosion and accretion are expected to occur. The downstream (southwestern) end of the cut-off wall is located at the start of an outside part of a meander bend where erosion can be expected. The geometry of the meander at the open-pit and cut-off wall location indicates that the locations of maximum erosion would be expected to occur beyond the project site in the downstream direction.

4.2 Channel Stability Observations

Figure 2 and Figure 3 show the observed historical channel migration during the 78 year period from 1938 to 2016 based on delineating the position if the riverbanks on successive images and then overlaying the delineated riverbank locations. During the historical period the channel and islands appear to have migrated very little. This is consistent with findings in other hydraulically regulated rivers. The largest changes in riverbank location occurs on the mid-channel islands. The changes in island shape and location is most apparent between 1938 and later years. However, as the images occurred at varying water levels the magnitude of change may be overestimated as portions of the islands could be hidden under high water conditions.

During the 78 year period, limited to no channel migration was identified in the direction of the proposed cut-off wall and open pit. The historical positions of the riverbank suggests that both erosion and accretion have been occurring along the left (looking downstream) riverbank in the location of the cut-off wall and open pit. These occurrences of erosion and accretion appear to be natural in origin, and related to river processes.

The maximum scale of change in riverbank position adjacent to the project site is conservatively estimated to be of the order of 10 m over a period of 78 years. The riverward margin of the pit is situated behind a cut-off wall that is located approximately 100 m from the present riverbank. The likelihood from this analysis of riverbank erosion reaching the cut-off wall or the pit during an activity window of 50 years (assumed for the purpose of this analysis as a reasonable planning period to cover the years of mine operational life, closure and into the early part of post-closure life) is negligible.

The relict terrace elevation has a surface elevation that is, at a minimum, approximately 1.7 m above the 100 year flood elevation. This elevation difference indicates that the terrace, and the pit within the terrace, it is unlikely to be inundated from overland flow generated by a 100 flood event. The relict terrace is an old feature that is no longer actively worked by the river. The elevation of the terrace above the current typical floodplain suggests that the river is degradational and that channel aggradation is not expected to occur and raise the flood level by sedimentation. The inferred bedrock nature of the observed rapids is consistent with this interpretation. The anticipated low sediment load conditions of the river downstream of the dam is also consistent with this interpretation.

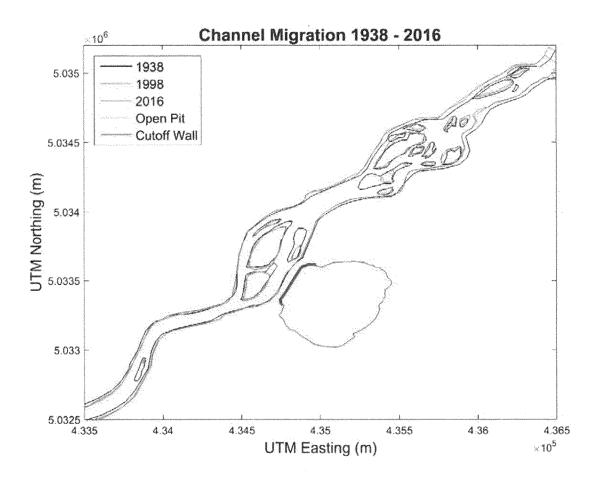


Figure 2: Estimated channel and island migration between 1938 and 2016.

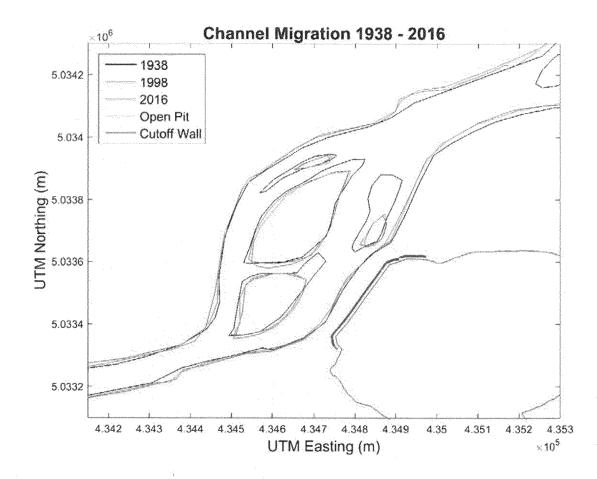


Figure 3: Zoom in of the estimated channel and island migration between 1938 and 2016.

4.3 River Thalweg Analysis

A thalweg analysis was carried out to enable interpretation of potential future changes in the river location. The thalweg is the line in a river that connects the deepest parts of a river and can be used as an indicator of lateral channel migration and riverbank erosion. Riverbank erosion commonly occurs where the thalweg is located close to the riverbank. Available river cross-section data, air photo interpretation, and hydraulic theory were used to infer the alignment of the thalweg adjacent to the project.

Figure 4 shows the thalweg migration during the 78 year period. The thalweg alignment is consistent with the interpretation of the project site being located primarily along a straight section of river and at the downstream end at the start of the outside bank of a meander. The thalweg alignment is also consistent with the interpretation of the expected location of greatest erosion along this section of riverbank occurring downstream of the mine site. In general the thalweg has maintained the same course where it flows past the project and is inferred to exhibit only minor deviations through the sand bars and islands upstream. The thalweg passes through the river reach (to the left of the mid channel islands) that flows past the project.

The inferred thalweg alignment indicates that erosion pressure on the left bank (east bank where the project is located) may be expected to increase downstream of the project location. This is because the thalweg shifts from the centre of the channel to a position closer to the left bank. The thalweg is situated closer to the right

bank upstream of the project. The shift in thalweg from right bank top left bank past the project suggests that riverbank erosion can be expected to remain similar to historical estimates for the foreseeable future.

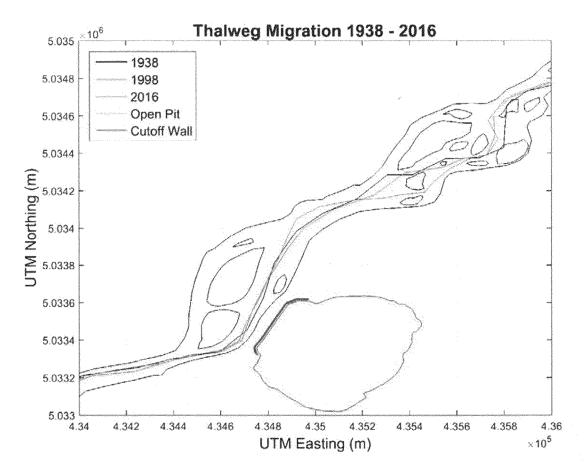


Figure 4: Migration of the thalweg between 1938 and 2016

4.4 Meander Belt Width Analysis

The potential extent (outer limits) of the river channel over geological history was assessed by conducting a meander belt width analysis. The results of this analysis are shown on Figure 5. This analysis provides an estimate of the active river corridor over geological time, e.g. over centuries to millennia, to establish a longer term potential for river channel changes and future river channel locations.

The meander belt width assessment is based on analysis of geomorphically observable features that indicate past locations of channels. These can include abandoned meanders, eroded meander scars, relict terraces, or other geomorphological features that are indicative of old channel locations. The inferred meander belt corridor extends further away from the river on the right bank than on the left bank as a result of abandoned meanders being observable in the air photos.

On the left bank of the river at the project site, the meander belt width assessment suggests that the river has been relatively confined over geological time. Limited evidence for meander development along the left



riverbank could be observed. The proposed pit location just intersects the inferred meander belt width analysis. This is primarily due to the pit extending to the relict terrace along the left bank of the river. The analysis suggests that were the river to migrate, it would require a significant length of time (e.g. several millennia) for the river to reach the proposed pit location.

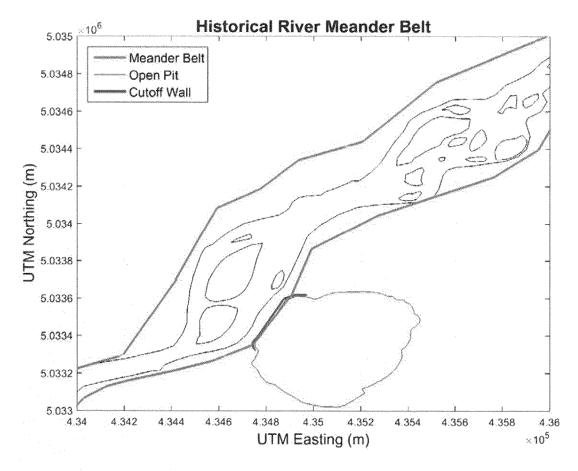


Figure 5: Meander belt width analysis for the project reach

5.0 CONCLUSIONS

- Based on this analysis, the river flowing past the pit is relatively stable over the historical period. Golder understands that monitoring of the riverbank will be carried out for slope stability purposes.
- The relict terrace containing the pit is situated at an elevation that is approximately 1.7 m above the estimated 100 year flood elevation. This implies that the terrace is unlikely to flood during a 100 year event.
- The maximum conservatively estimated change in riverbank position near the project site was of the order of 10 m over the 78 years of image record.
- The river thalweg alignment appears to be relatively stable and implies that the historical erosion analysis can reasonably be used as a guide for future estimates of erosion.

March 29, 2018

- The meander belt width analysis suggests the river will not reach the pit location over in the foreseeable
- The assessment indicates that the likelihood of the river eroding into the cut-off wall pit over an activity window of 50 year (assumed as a planning period to cover operational life, closure and the early part of post-closure of the mine) is negligible.

Golder Associates Ltd.

Ring May

David Hurley, MASc Coastal Specialist

DH/RA/KBH/sk

Rowland Atkins, MSc Principal, Senior Geomorpholigist

n/lactivet/2016/3 proj/1671468 aquila_tmf and wrfs design update_back forty/phase 3000\river bank stability\2-erosion and stability\text\final\1671468_channel migration tm-rev 0_29mar/2018.docx

REFERENCES

Foth Infrastructure & Environment, LLC (Foth), 2016. Memorandum on Flood Frequency Analysis. Master File 14A021/6000. June 1, 2016.

United States Environmental Protection Agency (USEPA), 2018. Public Notice No. 2NN-5PE0-MT3W, Aquila Resources Inc. A letter dated March 08, 2018, addressed to Ms. O'Keefe of Land and Water Management Division of Michigan Department of Environmental Quality.

Attachment 3.1 NPDES Permit Fact Sheet with Surface Water Station Locations

FACT SHEET

PERMITTEE/FACILITY NAME: Aquila Resources Inc. / Back Forty Project

COUNTY: Menominee

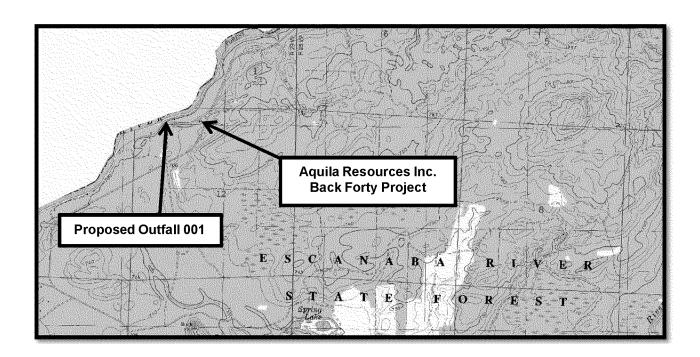
DESCRIPTION OF PROPOSED WASTEWATER TREATMENT FACILITIES

All water generated including storm water runoff will be collected in two lined contact water basins. Some quantities of water will be withdrawn, used, and returned to the contact water basins. Excess amounts of water from the contact water basins will be treated and discharged through outfall 001 to the Menominee River. Water will be pumped from the contact water basins to the treatment plant and treated in two mixed reactor tanks in series where sodium hydroxide or lime, coagulants, metal chelating polymers, flocculants, and sodium hypochlorite will be added. The water from the reactor tanks will flow to a clarifier and will then be followed by a filtration process with a membrane system. The pH of the effluent will be adjusted by adding sulfuric acid or sodium hydroxide prior to discharge. The solids generated by treatment will be thickened with a gravity thickener and the decant will be returned to the mixed tank reactors. The thickened solids will be processed by a plate and flame filter press and the resulting solids will be transported and disposed offsite.

Prior to returning to the contact water basins, pretreatment for the leachate from the oxide tailings and waste rock management facility may be added. Treatment steps similar to the treatment plant are proposed for the pretreatment.

MAP OF DISCHARGE LOCATION

<u>Facility Coordinates</u> Latitude 45.45068475, Longitude -87.8335155



RECEIVING WATER

The Menominee River is protected for agricultural uses, navigation, industrial water supply, public water supply in areas with designated public water supply intakes, warm-water fish, other indigenous aquatic life and wildlife, partial body contact recreation, total body contact recreation (May through October), and fish consumption.

The receiving stream flow used to develop effluent limitations is the 7-day Q10 flow of 940 cfs. This flow is used in accordance with previous agreements with the State of Wisconsin concerning design river flows for facilities that discharge to Michigan/Wisconsin border waters. The Wisconsin Department of Natural Resources reviewed the proposed effluent limits and concurred that they were protective of Wisconsin water quality standards. The 7-day Q10 flow is also equal to the lowest 95 percent exceedance flow of 940 cfs.

MIXING ZONE

For toxic pollutants, the volume of the Menominee River used to ensure that effluent limitations are sufficiently stringent to meet Water Quality Standards is 25 percent of the applicable design flow of the receiving stream.

For other pollutants, the volume of the Menominee River used to ensure that effluent limitations are sufficiently stringent to meet Water Quality Standards is the applicable design flow of the receiving stream.

PROPOSED EFFLUENT QUALITY: (from completed application dated December 8, 2015)

Parameter	Minimum Daily	Maximum Monthly	Maximum 7-Day	Maximum Daily	Units
Antimony				<u>< 2,300</u>	ug/l
Arsenic				<u>< 680</u>	ug/l
Barium				<u>< 2,845</u>	ug/l
Beryllium				<u>< 59</u>	ug/l
Boron				<u>< 55,000</u>	ug/l
Cadmium				<u>< 9.7</u>	ug/l
Chromium				<u>< 1,259</u>	ug/l
Cobalt				<u><</u> 740	ug/l
Copper				<u><</u> 30	ug/l
Cyanide				< 44	ug/l
Fluoride				<u><</u> 3,100	ug/l
Lead				< 440	ug/l
Lithium				<u>< 1,800</u>	ug/l
Manganese				<u>< 9,270</u>	ug/l
Mercury				< 0.0013	ug/l
Molybdenum				<u>< 58,000</u>	ug/l
Nickel				<u>< 1,038</u>	ug/l
Phosphorus				<_1,000	ug/l
Selenium				<u>< 120</u>	ug/l
Silver				<u>< </u> 0.06	ug/l
Zinc				273	ug/l

PROPOSED EFFLUENT LIMITATIONS: (see draft permit)

BASIS FOR PROPOSED EFFLUENT LIMITATIONS: (see Basis for Decision Memo)

ADDITIONAL INFORMATION

The Department proposes that the applicant's Antidegradation Demonstration, based on information required by Subrule (4) of R323.1098, shows that lowering of water quality is necessary to support the identified important social and economic development in the area. This is solely for purposes of satisfying state water quality regulations and is not intended to supplant local requirements, including land use or zoning laws. It is not, and should not be construed as, a finding by the Department that the proposed development meets local requirements or ordinances.

PUBLIC COMMENT

The draft NPDES permit was on public notice between August 3, 2016 and September 2, 2016. A responsiveness summary and copies of the individual response letters to comments received in writing during the NPDES public notice period are available to the public in MiWaters.

In addition, a 64 day consolidated public comment period was held from September 1, 2016 through November 3, 2016. A consolidated public hearing was held on October 6, 2016 on the Aquila Resources Inc-Back Forty Mine Project regarding the permit applications and draft permits for air, mining, and water. Response to comments received during the consolidated public hearing can be found in the document titled "Compiled Responses to Public Comments Regarding the Permit Applications and Related Regulatory and Administrative Concerns about the Proposed Back Forty Mine Project" at the following link: http://www.michigan.gov/documents/deq/deq-oogm-Mining-AquilaBack40-responsecomments 547561 7.pdf.

ACTIONS TAKEN TO ADDRESS COMMENTS RECEIVED

1. Based on comments received, a reopener clause was added to Part I, Section A.1.j. of the permit. The reopener clause references the required ambient surface water monitoring in the Part 632 Mining permit, and incorporates the requirement to submit the ambient surface water data, into the NPDES permit.

The ambient surface water monitoring must be collected quarterly, at each location for the parameters listed in Table 2.1 of the Environmental Monitoring Plan submitted with the Part 632 Mining permit application. Table 1 below lists the specific locations where ambient surface water sampling must be conducted consistent with the Environmental Monitoring Plan. Table 2 lists the parameters required to be sampled, the analytical method, and detection level for each parameter.

Figure 1 shows the location of the ambient surface water monitoring coordinates listed in Table 1.

- 2. Based on comments received, Whole Effluent Toxicity (WET) testing requirements using a freshwater mussel species (*Ambleca plicata*), native to the Menominee River, have been added to Part I, Section A.1.i. of the permit due to the sensitivity of these organisms to a variety of contaminants.
- 3. Based on comments received, the quantification level for arsenic was reduced from 1.0 ug/l to 0.5 ug/l.

Table 1: Ambient Surface Water Monitoring Station Locations and Descriptions¹

Site			
Name	Waterbody	Latitude	Longitude
MSG-1	Shakey Lake System - Long Lake	45.42067521	-87.84253047
MSG-2	Shakey Lake System – Bass Lake	45.41550164	-87.82074879
MSG-3	Shakey Creek	45.42050841	-87.78635801
MSG-4	Shakey River	45.44943693	-87.76443477
MSG-5	Little Shakey River	45.44867032	-87.75038542
MSG-6	Shakey River	45.46419466	-87.76761881
MSG-7	Shakey River	45.47178551	-87.76283686
MSG-8	Menominee River Tributary – Boerner Lower	45.46409072	-87.81193755
MSG-9	Menominee River Tributary – Unnamed (Schoneks)	45.47250087	-87.80469452
MSG-10	Menominee River	45.45090613	-87.83507940
MSG-11	Menominee River	45.38415846	-87.86635280
MSG-12	Shakey River	45.45585030	-87.77272923
MSG-13	Menominee River	45.45705168	-87.82986579
MSG-14	Menominee River	45.44360004	-87.84754471
MSG-15	Shakey Lakes System – Spring Lake	45.43130476	-87.82276211
MSG-16	Menominee River Tributary – Unnamed (WE Creek)	45.48036555	-87.80170459
MSG-17	Spring Creek	45.43855000	-87.82766000
MSG-18	Menominee River Tributary – Boerner Upper	45.46220000	-87.81110000
MSG-19	Menominee River Tributary – Boerner Lower	45.46421000	-87.81224000
MSG-20	Unnamed Tributary to Boerner Upper	45.45568600	-87.80680500

¹ Environmental Monitoring Plan, Appendix G, Part 632 Mining Permit Application, October 2015; the Part 632 Mining Permit MP 01 2016, and the Memorandum, Back Forty Project – Surface Water Monitoring Location Clarification, Foth Infrastructure & Environment, LLC, March 21, 2017.

Table 2: Ambient Surface Water Sampling Parameter List

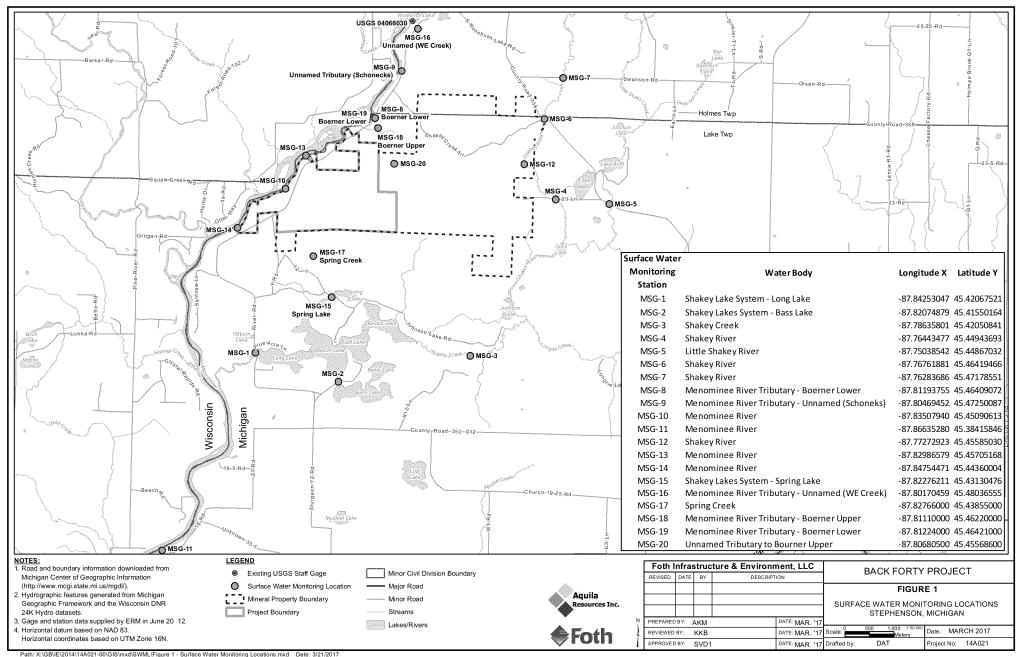
Detection					
Parameter	Units	Analytical Method	Level		
Field		•			
Oxidation Reduction Potential	mV	Field Measured	NA		
Field pH	S.U.	Field Measured	NA		
Specific Conductance	umhos/cm	Field Measured	NA		
Temperature	°F	Field Measured	NA		
Dissolved Oxygen	mg/l	Field Measured	NA		
Color	PČU	Field Measured	NA		
Turbidity	NTU	Field Measured	NA		
Lab			ı		
Acrylamide	μg/l	8032A/8316/8270C	0.5		
Alkalinity, Bicarbonate	mg/l	EPA 310.1/SM 2320 B	10.0		
Alkalinity, Carbonate	mg/l	EPA 310.1/SM 2320 B	10.0		
Ammonia	mg/l	EPA 350.1	0.02		
Antimony	μg/l	EPA 200.8/6020	2.0		
Arsenic	μg/l	EPA 200.8/6020	5.0		
Cadmium	μg/l	EPA 200.8/6020	1.0		
Calcium	mg/l	EPA 200.7/6010 B	0.50		
Chloride	mg/l	EPA 325.2/4500 CL E	1.0		
Copper	μg/l	EPA 200.8/6020	4.0		
Cyanide	μg/l	EPA 335.4	0.005		
Fluoride	mg/l	9056A	0.1		
Hardness	mg/l	SM 2340C	1.0		
Iron	mg/	EPA 200.7/6010 B	200		
Lead	μg/l	EPA 200.8/6020	3.0		
Magnesium	μg/l	EPA 200.7/6010 B	1.0		
Manganese	μg/l	EPA 200.8/6020	50		
Mercury	ng/l	EPA 1631 E	0.5		
Nickel	μg/l	EPA 200.8/6020	1.0		
Nitrate-N	mg/l	EPA 353.2/4500 NO3F	0.02		
Nitrite	mg/l	EPA 353.2 or 353.1/4500 NO2B	0.02		
Potassium	mg/l	EPA 200.7/6010 B	0.50		
Radium	pCi/l	EPA 930.1/904	1.0		
Selenium	μg/l	EPA 200.8/6020	5.0		
Silver	μg/l	EPA 200.8/6020	0.2		
Sodium	mg/l	EPA 200.7/6010 B	1.0		
Sulfate	mg/l	EPA 375.4/9038	2.0		
Sulfide	mg/l	EPA 376.1/4500 S2 F	1.0		
Total Dissolved Solids	mg/l	EPA 160.1	5.0		
Total Suspended Solids	mg/l	EPA 160.2	5.0		
Uranium	μg/l	ASTM D5174	0.25		
Volatile Organic Compounds	μg/l	8260B	various		
Zinc	μg/l	EPA 200.8/6020	500		

² Derived from Table 2-1 in the Environmental Monitoring Plan, Appendix G, Part 632 Mining Permit Application, October 2015; the Part 632 Mining Permit MP 01 2016, and the Memorandum, Back Forty Project – Surface Water Monitoring Location Clarification, Foth Infrastructure & Environment, LLC, March 21, 2017.

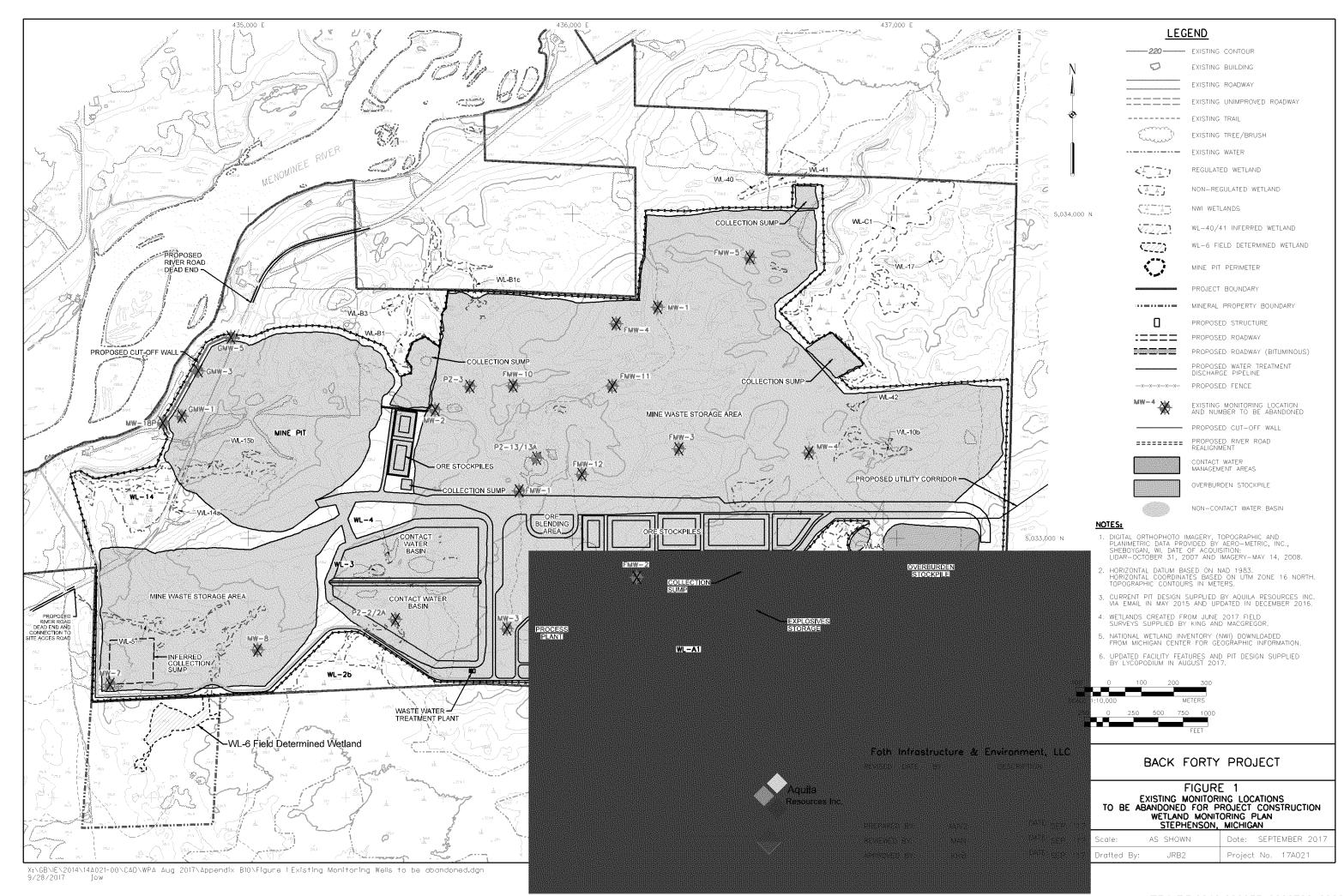
Table Abbreviations:

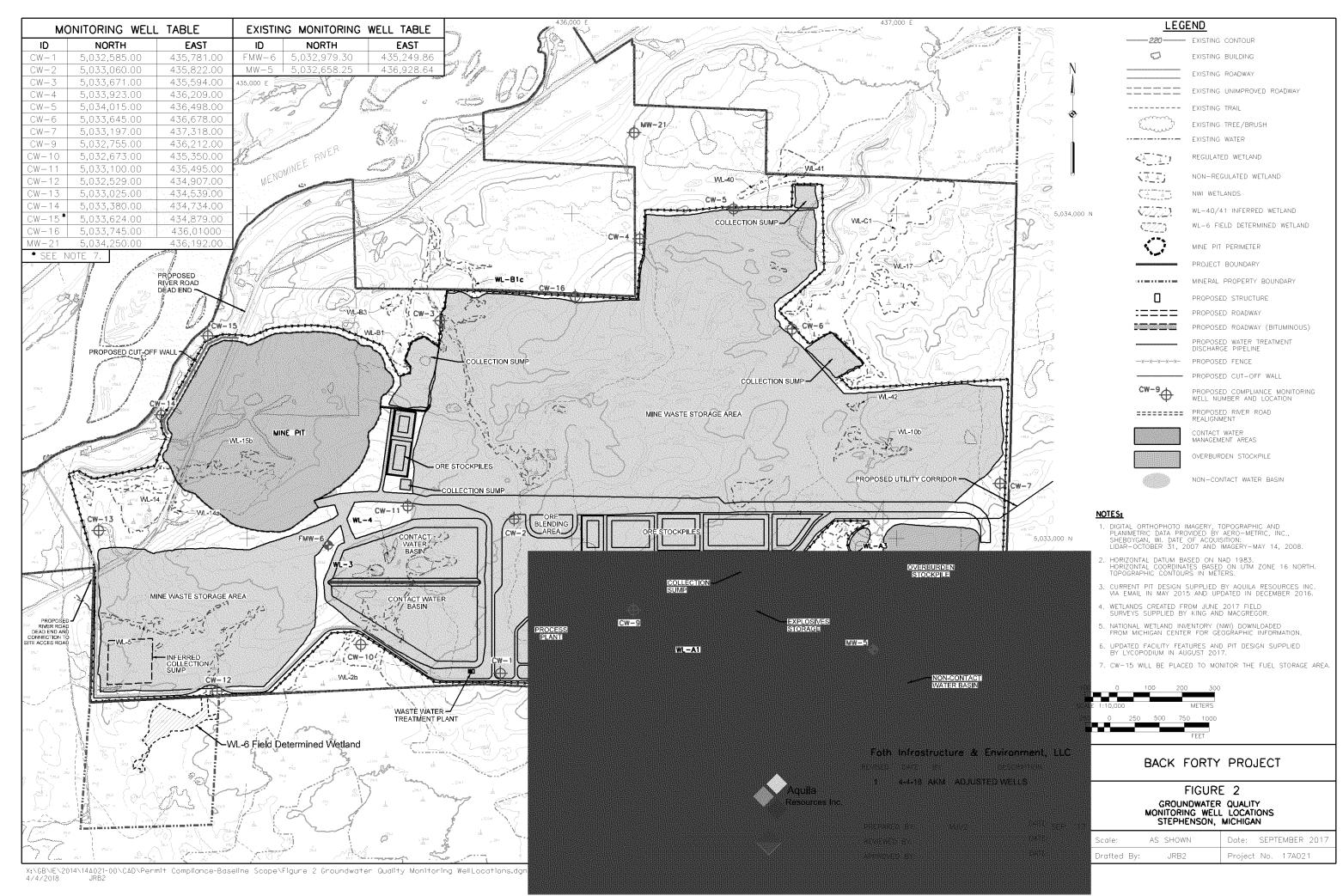
ASTM = American Society for Testing and Materials
EPA = Environmental Protection Agency
°F = degrees Fahrenheit
H₂SO₄ = Sulfuric acid
HNO₃ = Nitric acid
mg/l = milligrams per liter
mL = milliliters
mV = millivolts
NA = not applicable

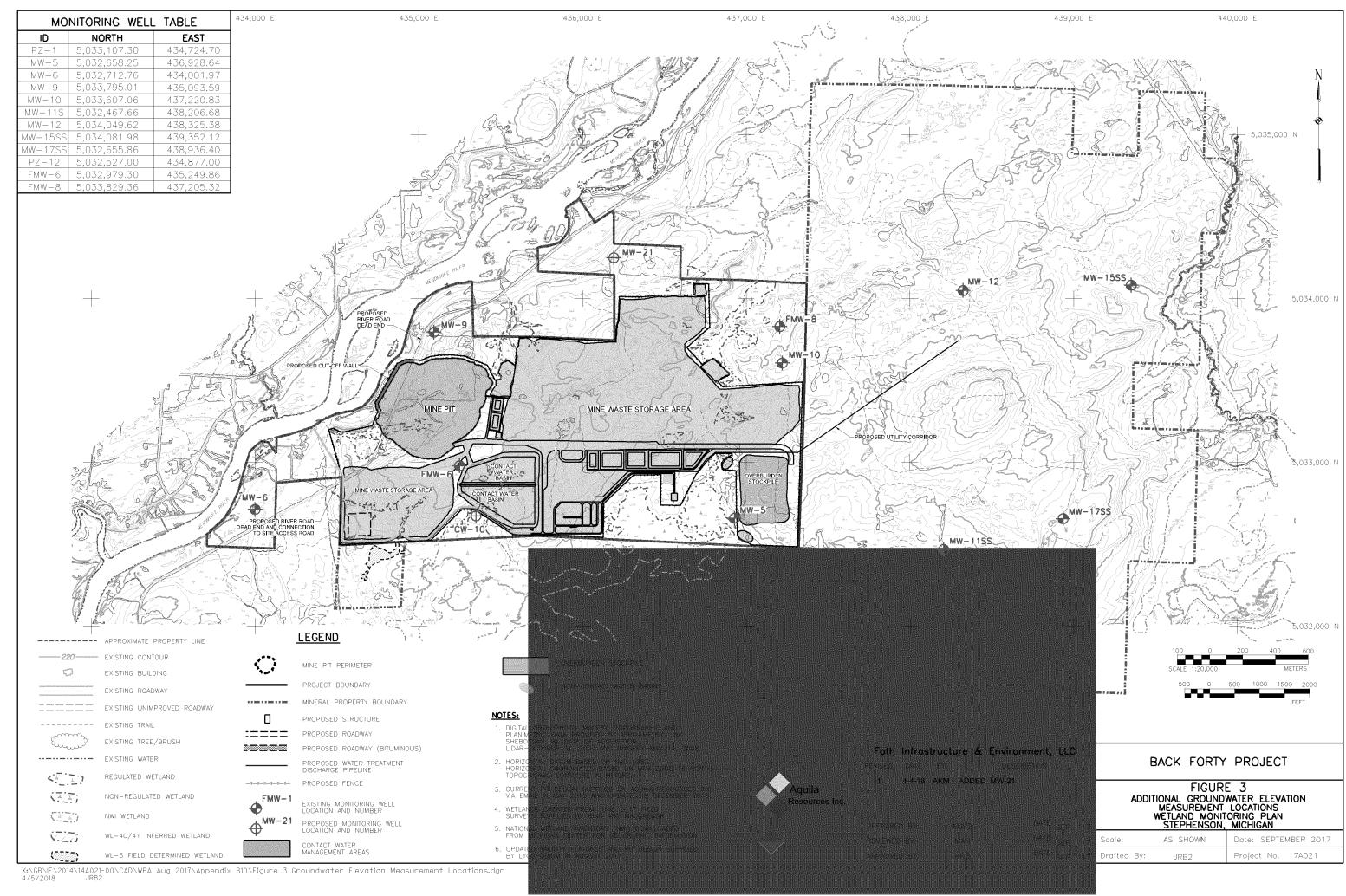
NaOH = Sodium hydroxide
ng/l = nanograms per liter
NTU = Nephelometric Turbidity Units
PCU = Platinum Cobalt Units
pCi/l = picocuries per liter
S.U. = standard unit
µg/l = micrograms per liter
µmhos/cm = micromhos per centimeter

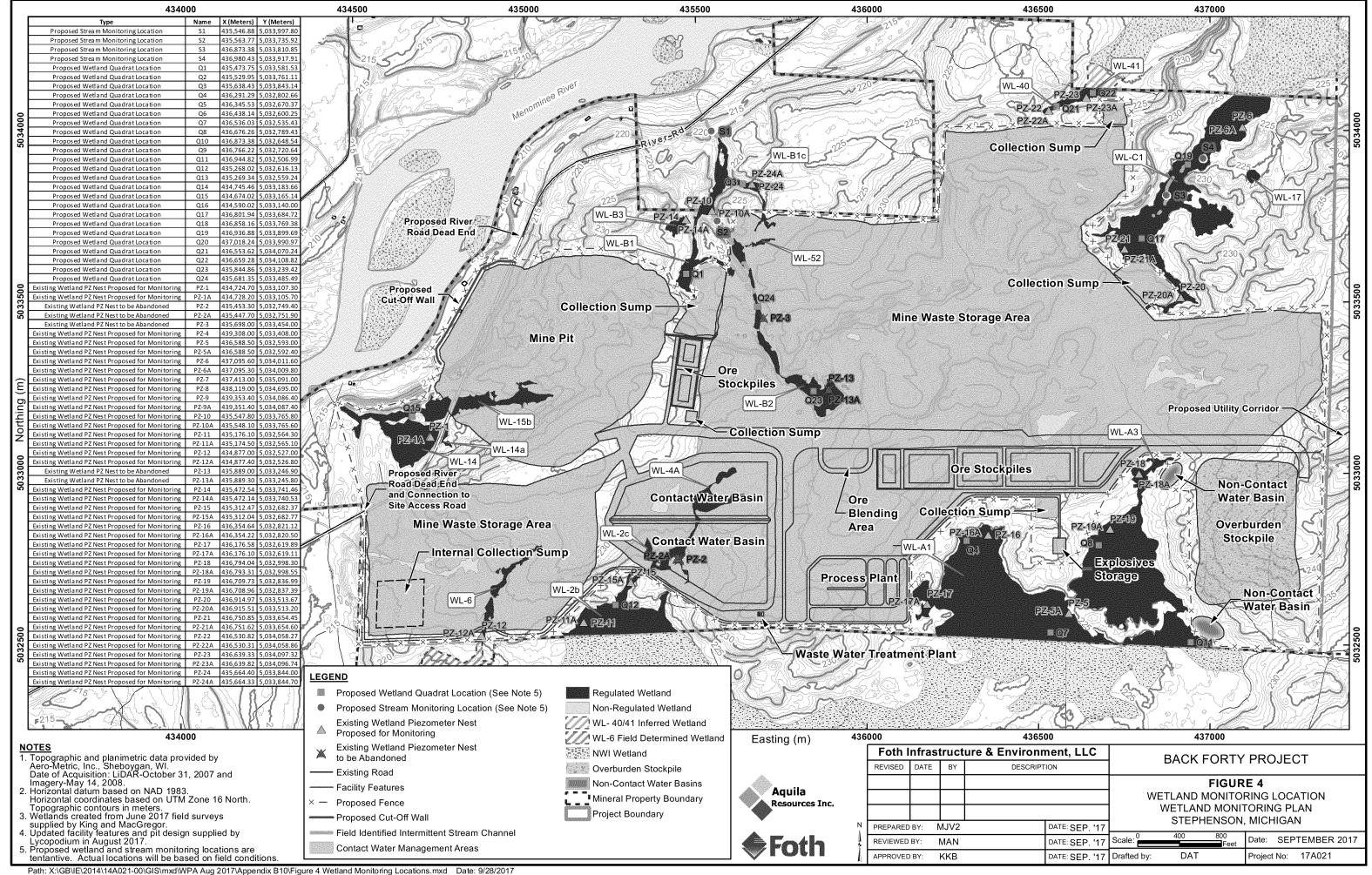


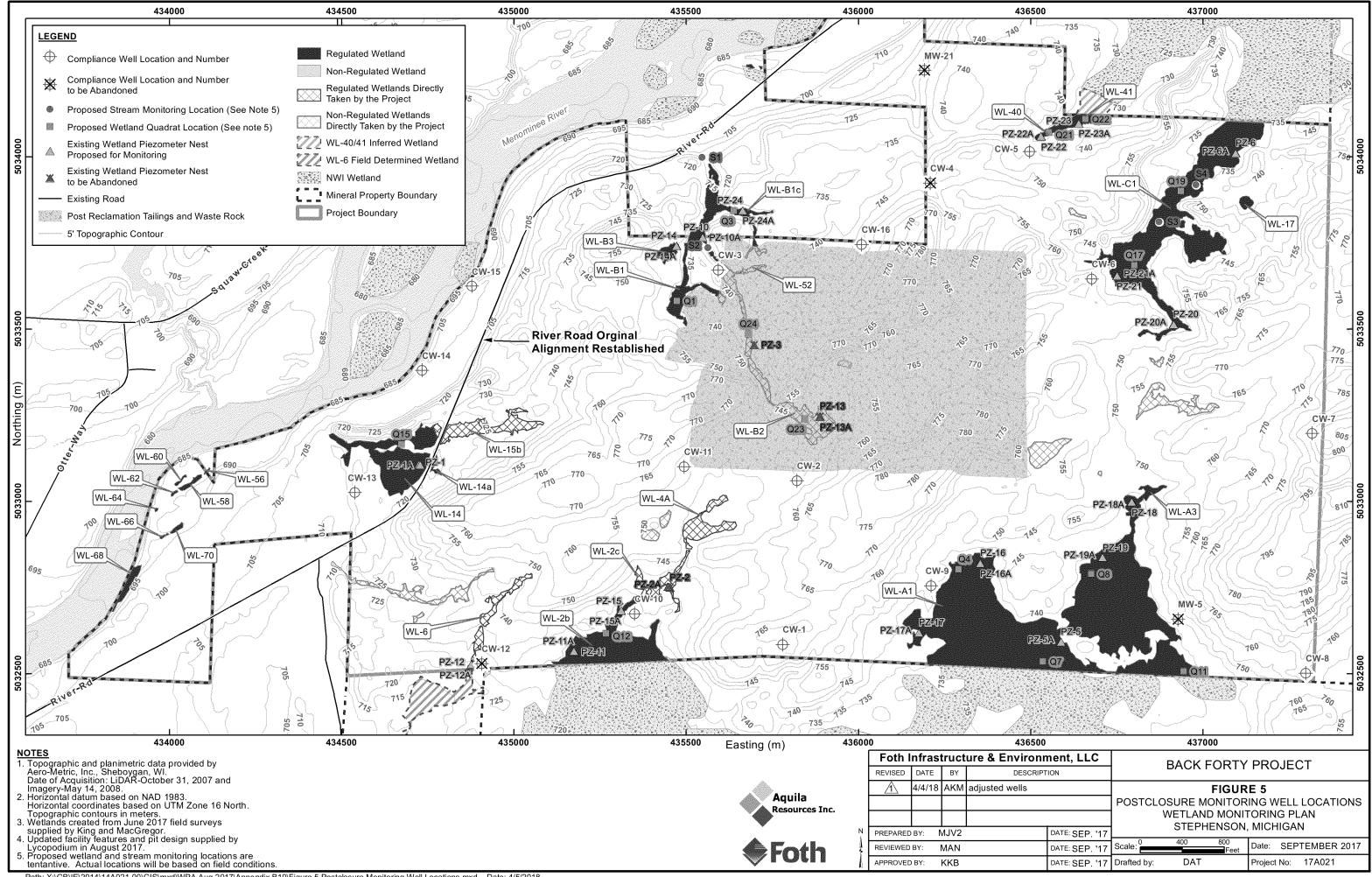
Attachment 3.2 Wetland Monitoring Plan Figures











Attachment 3.3 Water Quality Constituents of Interest in the Menominee River

Table 3-1
Water Quality Constituents of Interest in the Menominee River

Constituent of Interest	Units	Projected Concentration in Waste Rock Pore Water	Incremental Concetration Increase Under Low Flow Conditions ¹
Arsenic	ug/L	113	9.68E-05
Cadmium	ug/L	42	3.61E-05
Copper	ug/L	722	6.21E-04
Lead	ug/L	34	2.89E-05
Mercury	ug/L	8.96E-03	7.71E-09
Selenium	ug/L	14	1.22E-05
Silver	ug/L	0.7	6.14E-07
Zinc	ug/L	450	3.87E-04
			Prepared by: AKM

Prepared by: AKM Checked by: JEF1

Notes:

 1 Concentrations increase is max flux per unit time divided by (volume of groundwater passing pit and discharging to river plus volume of river flow at 90Q10 in same unit time).

Abbreviations:

90Q10 = 90-day, 10-year low flow (1370 cfs)

ug/L = micrograms per liter